multichannel systems

Microelectrode Array (MEA) Manual

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1 Introduction

1.1 About this Manual

The MEA manual comprises all important information about the microelectrode arrays (MEA) for use with (USB-) MEA- or ME-Systems from Multi Channel Systems. The MEA manual focuses on general information on the **MEA design**, **use**, and **handling**, and more specific information on different **MEA types**. It also includes recommendations on **sterilization**, **coating**, and **cleaning** procedures, from scientifical papers or from recommendations of other MEA users.

For more details on issues that refer to the amplifier, like grounding or mounting the MEA, please refer to the manual for the MEA amplifier you use. You will find more information about the MEA-System and its components in general, especially the data acquisition card, in the MEA-System manual. For more details on the data acquisition and analysis program Multi Channel Suite or MC_Rack, please refer to the manuals.

It is assumed that you have already a basic understanding of technical terms. No special skills are required to read this manual.

The components and also the manual are part of an ongoing developmental process. Please understand that the provided documentation is not always up to date. Please check the MCS Web site (www.multichannelsystems.com) from time to time for downloading up-to-date manuals.

Those parts in this manual that refer to the applications, and not to the product itself, for example, coating of MEAs, are only a summary of published information from other sources (see references) and has the intention of helping users finding the appropriate information for setting up their experiments. Multi Channel Systems MCS GmbH has not tested or verified this information. Multi Channel Systems MCS GmbH does not guarantee that the information is correct. Multi Channel Systems MCS GmbH recommends to refer to the referenced literature for planning and executing any experiments.

2 Important Information and Instructions

2.1 Operator's Obligations

The operator is obliged to allow only persons to work on the device, who

- are familiar with the safety at work and accident prevention regulations and have been instructed how to use the device;
- are professionally qualified or have specialist knowledge and training and have received instruction in the use of the device;
- have read and understood the chapter on safety and the warning instructions in this manual and confirmed this with their signature.

It must be monitored at regular intervals that the operating personnel are working safely.

Personnel still undergoing training may only work on the device under the supervision of an experienced person.

2.2 Guarantee and Liability

The *General conditions of sale and delivery* of Multi Channel Systems MCS GmbH always apply. The operator will receive these no later than on conclusion of the contract.

Multi Channel Systems MCS GmbH makes no Guarantee as to the accuracy of any and all tests and data generated by the use of the device or the software. It is up to the user to use good laboratory practice to establish the validity of his findings.

Guarantee and liability claims in the event of injury or material damage are excluded when they are the result of one of the following.

- Improper use of the device.
- Improper installation, commissioning, operation or maintenance of the device.
- Operating the device when the safety and protective devices are defective and/or inoperable.
- Non-observance of the instructions in the manual with regard to transport, storage, installation, commissioning, operation or maintenance of the device.
- Unauthorized structural alterations to the device.
- Unauthorized modifications to the system settings.
- Inadequate monitoring of device components subject to wear.
- Improperly executed and unauthorized repairs.
- Unauthorized opening of the device or its components.
- Catastrophic events due to the effect of foreign bodies or acts of God.

2.3 Important Safety Advice

Warning: Make sure to read the following advice prior to install or to use the device and the software. If you do not fulfill all requirements stated below, this may lead to malfunctions or breakage of connected hardware, or even fatal injuries.

Warning: Obey always the rules of local regulations and laws. Only qualified personnel should be allowed to perform laboratory work. Work according to good laboratory practice to obtain best results and to minimize risks.

The product has been built to the state of the art and in accordance with recognized safety engineering rules. The device may only

- be used for its **intended purpose**;
- be used when in a **perfect condition**.
- Improper use could lead to serious, even fatal injuries to the user or third parties and damage to the device itself or other material damage.

Warning: The device and the software are **not** intended for medical uses and **must not** be used on humans.

- Malfunctions which could impair safety should be rectified immediately.
- Regard the technical specifications of the various MEA types, especially the temperature range and the safe charge injection limits for stimulation.
- Do not autoclave or expose pMEAs to heat more than 50 °C.
- Do not touch the electrode field in any way.
- Do not use any liquids or cleaning solutions with a high pH (> 7) for a longer period of time on MEAs of a silicon nitride insulation type. Basic solutions will damage TiN electrodes.

3 Microelectrode Arrays (MEAs) — Overview

3.1 Extracellular Recording with Microelectrode Arrays

A microelectrode array (MEA) is an arrangement of typically 60 electrodes allowing the targeting of several sites in parallel for extracellular recording and stimulation.

Cell lines or primary cell preparations are cultivated directly on the MEA. Freshly prepared slices can be used for acute recordings, or can be cultivated as organotypic cultures (OTC) on the MEA.

Recorded signals are amplified by a filter amplifier and sent to the data acquisition computer. All MEAs (except EcoFlex- or FlexMEAs) are only for use with MEA-Systems or USB-MEA-Systems for extracellular recording from Multi Channel Systems MCS GmbH. FlexMEAs may be used with components of ME-Systems and USB-ME-Systems from Multi Channel Systems MCS GmbH. EcoFlex- and FlexMEAs are designed for use in *in vitro* or *in vivo* studies. Please see setup manuals "Setup (USB-) MEA-Systems and (USB-) ME-Systems" for more information.

Several MEA geometries are provided for a wide variety of applications. Almost all excitable or electrogenic cells and tissues can be used for extracellular recording *in vitro*, for example, central or peripheral neurons, cardiac myocytes, whole-heart preparations, or retina.

There are various applications for MEAs in the fields of neurobiology and cardiac electrophysiology.

Typical neurobiological applications are: Ion channel screening, drug testing, safety pharmacology studies, current source density analysis, paired-pulse facilitation (PPF), long term potentiation (LTP) and depression (LTD), I / O relationship of evoked responses, circadian rhythm, neuroregeneration, developmental biology, microencephalograms (EEG), and microelectroretinograms (ERG).

Typical applications in the cardiac field are: Activation and excitation mapping, measuring of the conduction velocity, longterm characterizations of cell types (especially stem cells), culture pacing, drug testing, safety pharmacology studies, monitoring of QT-related prolongation and arrhythmias, cocultures and disease / implantation model.

For more information on published applications or procedures for biological preparations, please see the application notes on the MCS web site:

http://www.multichannelsystems.com/applications.html

3.2 MEA Design and Production

A standard MEA biosensor has a square recording area of 700 µm to 5 mm length. In this area, 60 electrodes are aligned in an 8 x 8 grid with interelectrode distances of 100, 200, or 500 µm. Planar TiN (titanium nitride) electrodes are available in sizes of 10, 20, and 30 µm, and three-dimensional TiN electrodes have a diameter of > 20 µm at the base with a very fine tip. Standard MEAs are useful for a wide variety of applications. Different geometries match the anatomical properties of the preparation. Most MEAs are available with a substrate-integrated reference electrode replacing the silver pellet in the bath. All electrodes can either be used for recording or for stimulation.

In principle MEA electrodes are not arranged symmetrical, so the MEA chip has to be placed inside the amplifier in the recommended manner.

Several other MEA types and layouts that are dedicated to special applications are also available, please see chapter "MEA Types and Layouts" for more details.

The biological sample can be positioned directly on the recording area; the MEA serves as a culture and perfusion chamber. A temperature controller controls the temperature in the culture chamber. Various culture chambers are available, for example, with leak proof lid or with semipermeable seal. An incubator is not necessarily required, long-term recordings in the MEA culture chamber are possible over several weeks or even months.

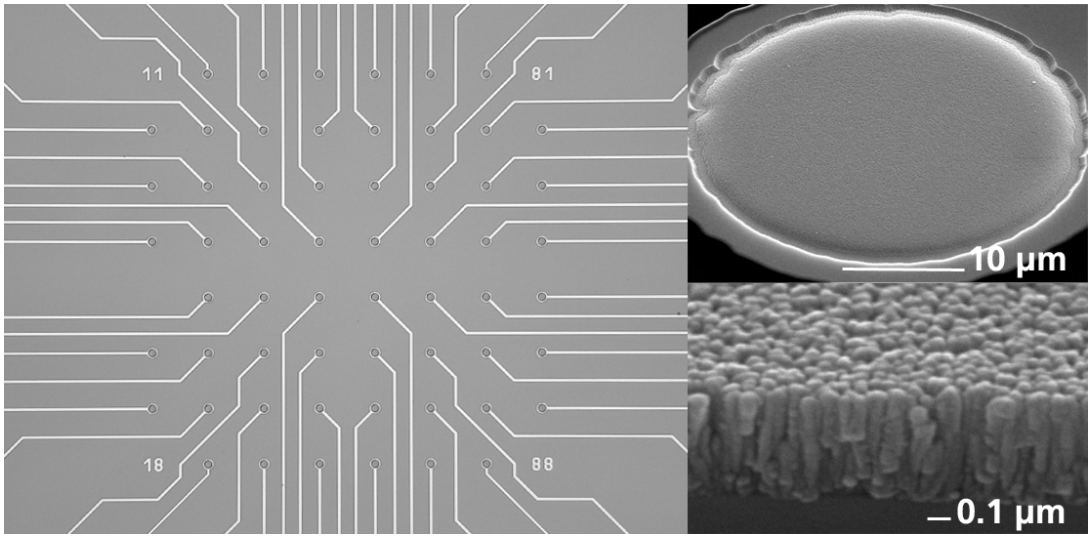
For cell or slice cultures, MEAs have to be coated with standard procedures before use to improve the cell attachment and growth, please read chapter "MEA Coating".

Spike activity can be detected at distances of up to 100 µm from a neuron in an acute brain slice. Typically, signal sources are within a radius of 30 µm around the electrode center. The smaller the distance, the higher are the extracellular signals. The higher the spatial resolution, the lower the numbers of units that are picked up by a single electrode, that is, the less effort has to be put into the spike sorting.

Multi Channel Systems provides MEAs with the highest spatial resolution in the market. HighDenseMEAs have electrodes with a diameter of only 10 µm arranged in a distance of only 30 µm (center to center). The challenge of manufacturing very small electrodes and at the same time keeping the impedance and the noise level down has been met by introducing a new electrode material: Titanium nitride (TiN).

The NMI in Reutlingen, Germany (www.nmi.de), produces MEAs from very pure fine quality and highly biocompatible materials. The NMI is a research institute, with which Multi Channel Systems has collaborated in many projects and over many years.

Quality controls and production processes have been improved over the last years so that MEAs are always of a fine consistent quality at very reasonable prices.



3.3 Electrodes, Tracks, and Insulation

Microfold structures result in a large surface area that allows the formation of electrodes with an excellent signal to noise ratio without compromising on the spatial resolution.

TiN (titanium nitride) is a very stable material that, for example, is also widely used for coating heavy equipment. All MEAs with TiN electrodes have a long life and can be reused several times if handled with care. If used for acute slices, MEAs can be used for approximately one year. Additionally available are EcoMEAs equipped with gold (Au) electrodes.

Long-time experiments with cell cultures and rigid cleaning methods shorten the MEA lifetime, but you can still reuse a MEA about 30 times, depending on the coating, cell culture, and cleaning procedure. All MEAs (except pMEAs) show excellent temperature compatibility and are stable from 0 °C to 125 °C, that is, they can be autoclaved.

The impedance of a flat, round titanium nitride (TiN) electrode ranges between 30 and 400 kiloohms, depending on the diameter. The smaller an electrode, the higher is the impedance. On one hand, lower impedance seems desirable, but on the other hand, a smaller electrode and interelectrode distance results in a higher spatial resolution.

Multi Channel Systems provides MEAs with TiN electrodes with sizes of 10, 20, or 30 µm and gold electrodes with 100 µm, which all show an excellent performance and low noise level. The average noise level of 30 µm and 10 µm electrodes is less than 10 µV and 15 µV peak to peak, respectively.

Gold electrodes (EcoMEAs) are only available with a low spatial resolution and are useful for medium throughput screening, where costs are a limiting factor.

All planar TiN electrodes are positioned on a round pad with a diameter of 40 µm. If you like to check the electrodes with a light microscope, you will need an upright microscope to see the MEA from above. With an inverse microscope, you are only able to see the (bigger) pad from below, not the electrode itself.

The electrodes are embedded in a carrier material, usually glass. Standard tracks made of titanium (Ti) or indium tin oxide (ITO) are electrically isolated with silicon nitride (SiN). Standard contact pads are made of titanium nitride (TiN) or indium tin oxide (ITO). ITO contact pads and tracks are transparent, for a perfect view of the specimen under the microscope.

4 MEA Types and Layouts

Various types of MEA biosensors are available for all kind of extracellular multi channel recordings.

Typical MEAs for ***in vitro*** applications have 60 microelectrodes arranged in an 8 x 8 layout grid embedded in a transparent glass substrate. You can cultivate the tissue or cell culture directly on the MEA. EcoFlex- and FlexMEAs are made for ***in vivo*** and ***in vitro*** applications.

MEA types differ in the materials used for the carrier and the recording area, and in the geometry, that is, electrode size and interelectrode distances. The electrode size and interelectrode distances are used for categorizing MEAs: The first number refers to the interelectrode distance, for example 200 µm, and the second number refers to the electrode size, for example 10 µm, which results in the standard MEA type 200/10, for example.

Standard versions are available with an internal reference electrode (abbreviated "iR") and with various culture chamber interface options. Culture chambers are available with and without lid.

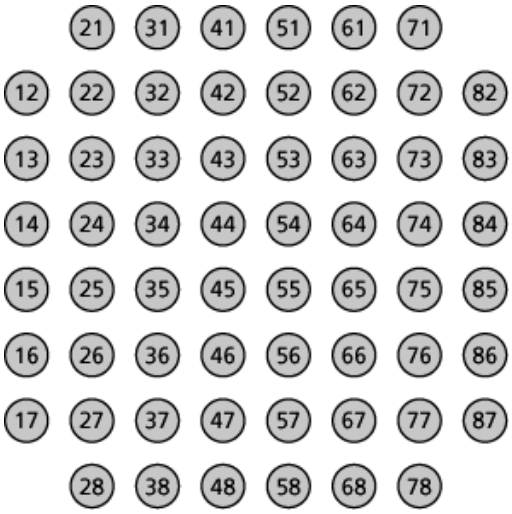
Please ask for custom layouts, that is, MEA layouts according to your specifications.

In this chapter, each MEA type is briefly described and noted.

- Standard MEAs with flat round TiN electrodes in an 8 x 8 layout grid for all applications.
- MEAs with 6 x 10 layout grid and 500 µm inter electrode distances.
- HighDenseMEAs with the highest spatial resolution and a double recording field of 5 x 6 electrodes each.
- HexaMEAs featuring a hexagonal layout, perfect for recording from retina.
- ThinMEAs with a "thickness" of only 180 µm, ideally suited for high-resolution imaging.
- Very cost efficient and robust EcoMEAs on glass or PCB (printed circuit board) base for applications with lower spatial resolution and higher throughput, especially for established cardiomyocyte cultures, large slices, or whole-heart preparations.
- Stimulation MEAs with 16 additional stimulation electrodes.
- Perforated MEAs allow perfusing the acute slice from up- and downside. For use with MEA2100 headstages equipped with perfusion element (MEA2100-PE) and MEA1060 amplifiers with perfusion ground plate (MEA-PGP) or with.
- Small perforated MEAs with 32 recording and 12 stimulation electrodes specified for use with MEA2100-32- and USB-MEA32-STIM4-System.
- 6 well MEAs feature a round MEA layout, separated in six segments of 3 x 3 electrodes, like a pie-chart. Using the 6 well MEA with macrolon triangle or round chamber ring, you have 6 separate culture chambers on one MEA, for example, for drug application in a screening experiment.
- 4 quadrant 1000 MEAs with electrode layout organized in four quadrants and a center line.
- 256MEAs with 252 recording electrodes in a 16 x 16 layout grid for use with USB-MEA256-System.
- 6 well MEAs for use with USB-MEA256-System. 252 electrodes in 6 blocks of 6 x 7 electrodes in a round layout for use with 6 well macrolon triangle or round chamber rings. You have 6 separate culture chambers on one MEA, for example, for drug application in a screening experiment.
- 9 well MEAs for use with USB-MEA256-System. 256 electrodes in nine blocks of 26 recording, two stimulation and reference electrodes each. Using the 9 well MEA with macrolon quadrant, you have 9 separate culture chambers, for example, for drug application in a screening experiment.
- 120MEAs and a perforated 120pMEA with 12 x 12 layout grid for use with MEA2100-120-System only.

- Square MEAs with TiN (Titanium nitride) electrodes in 50 x 50 µm square size in a 8 x 8 layout grid.
- PEDOT-CNT MEAs with carbon nanotube – poly 3,4-ethylene-dioxythiophene electrodes and gold tracks and contact pads have very low impedance values of approximately 20 kΩ. They are ideal for stimulation and have excellent biocompatibility and cell adhesion.
- FlexMEAs made of flexible polyimide 2611 foil, perfect for *in vivo* and specific *in vitro* applications, for example, whole-heart preparations. Available with 36 (FlexMEA36) or 72 (FlexMEA72) TiN (Titanium nitride) electrodes.
- EcoFlexMEAs made of flexible polyimide (Kapton) as well, but very cost efficient and more robust than FlexMEAs from polyimide foil. Available with 36 (EcoFlexMEA36) or 24 (EcoFlex24) gold electrodes.

4.1 Standard Electrode Numbering



The numbering of MEA electrodes in the 8 x 8 grid (standard MEAs, ThinMEAs, EcoMEAs, StimMEAs, pMEAs) follows the standard numbering scheme for square grids: The first digit is the column number, and the second digit is the row number. For example, electrode 23 is positioned in the third row of the second column.

These numbers are the same numbers that are used as channel numbers in the MCS data acquisition software, for example the MC_Rack program. Using MC_Rack please make sure that you have selected the two-dimensional MEA layout as the "Channel Layout" in "Data Source Setup". For more details, please refer to the MC_Rack manual or help.

Important: MEAs are not symmetrical! That is, why the **writing** (for example NMI, LEITER, MEA type) on the MEA chip should be on the right side viewed from the front, with the sockets of the amplifier in the back. MEAs with one big internal reference electrode should be placed with reference electrode to the left side in the amplifier. Otherwise, the MEA layout will not match with the pin layout of the channel map in the data acquisition program.

Other electrode grids are described in the next chapter, and in the Appendix.

4.2 Standard MEA

60MEA100/10-ITO, 60MEA200/10iR-ITO, 60MEA200/30iR-ITO, 60MEA100/10iR-TI, 60MEA200/10-Ti, 60MEA200/30-Ti, 60MEA200/10iR-TI, 60MEA200/30iR-Ti,60MEA500/10iR-Ti, 60MEA500/30iR-Ti

Standard MEAs have 60 electrodes in an 8 x 8 layout grid with electrode diameters of 10 µm or 30 µm, and interelectrode distances of 100 µm, 200 µm. The MEAs with an interelectrode distance of 500 µm have a 6 x 10 layout grid.

Versions 200/10, 200/30, 100/10 are available without or with an internal reference electrode as indicated by the abbreviation iR. You can connect the internal reference electrode directly to the amplifier's ground and will not need silver pellets for grounding the bath anymore. Please refer to the MEA manual delivered with your MEA amplifier for more information.

The flat, round electrodes are made of titanium nitride (TiN). MEAs with TiN electrodes are very stable. Therefore, the MEAs can be reused several times and are perfect for long-time experiments (up to several weeks and even months). The electrode impedance ranges between 30 kΩ and 400 kΩ, depending on the electrode diameter. Generally, the smaller the electrode, the higher is the impedance.

Tracks are made of titanium (Ti) and contact pads are made of titanium nitride (TiN) or indium tin oxide (ITO); insulation material is silicon nitride. ITO contact pads and tracks are transparent, for a perfect view of the specimen under the microscope.

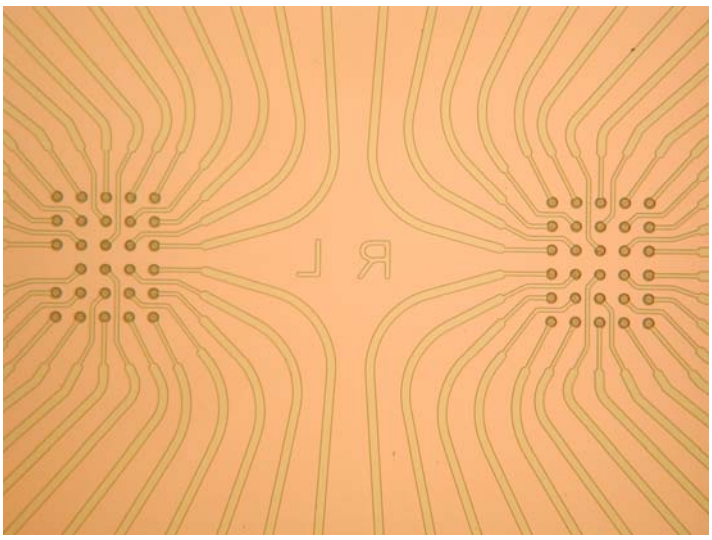
Important: MEAs are not symmetrical! That is, why the **writing** (for example NMI, LEITER, MEA type) on the MEA chip should be on the right side viewed from the front, with the sockets of the amplifier in the back. MEAs with one big internal reference electrode should be placed with reference electrode to the left side in the amplifier. Otherwise, the MEA layout will not match with the pin layout of the channel map in the data acquisition software.

Using standard MEAs

Standard MEAs can be used for a wide variety of applications. They are robust and heat-stabilized. They can be autoclaved and coated with different procedures for cell and tissue cultures. Generally, they can be used for acute experiments as well as long-term cultures.

4.3 High Density MEA: 60HDMEA

60HDMEA30/10iR-ITO



10 µm electrodes are arranged in two recording fields with 5 x 6 electrodes each. The interelectrode spacing is only 30 µm center to center.

The very high electrode density of the two recording fields on a 60HDMEA is only possible by the special TiN electrode material and production process. This MEA type is especially useful for applications, where a high spatial resolution is critical, for example, for multitrode analysis.

For example, the very high spatial resolution of the high density MEAs is very useful for recording from retina ganglia cells. The double recording field can also be used for coculturing two slices, each on one recording field. The flat, round electrodes are made of titanium nitride (TiN).Tracks and contact pads are made of transparent indium tin oxide (ITO); insulation material is silicon nitride.

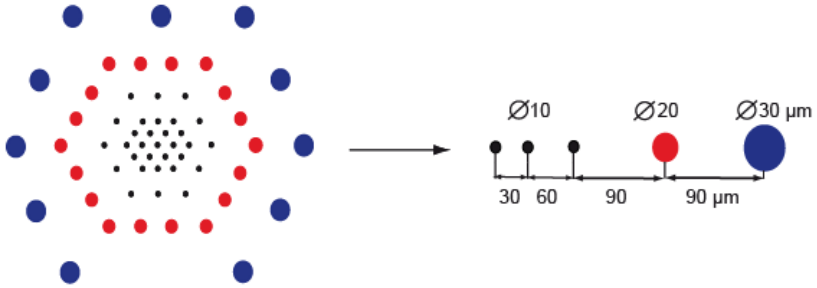
60HDMEA30/10iR-ITO MEAs are available with internal reference electrode.

Using 60HDMEAs

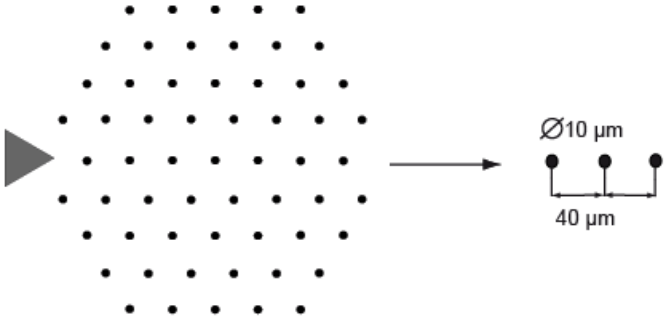
The same material is used for standard MEAs and high density MEAs. Therefore, they are equally robust and heat-stabilized. They can be autoclaved and coated with different procedures for cell and tissue cultures.

4.4 Hexa MEA: 60HexaMEA

60HexaMEA-Ti, 60HexaMEA-ITO, 60HexaMEA40/10iR-ITO



Electrode layout for 60HexaMEA-Ti and 60HexaMEA-ITO.



Electrode layout for 60HexaMEA40/10iR-ITO.

HexaMEAs feature a hexagonal layout, perfect for recording from retina.

The 60 electrodes of 60HexaMEA-Ti or 60HexaMEA-ITO are aligned in a special configuration with varying electrode diameters (10, 20, 30 µm) and interelectrode distances (see upper pictures).The specific layout resembles ideally the regularity of the retina's architecture. The density of neurons is more important in the center than in the peripheral. This is matched by the density of electrodes on the MEA, which is also higher in the center than in the peripheral.

The flat, round electrodes are made of titanium nitride (TiN).

Tracks are made of opaque Ti or transparent ITO, and contact pads are made of TiN or ITO.
The insulation material is silicon nitride.

Electrodes in the center have a diameter of 10 µm with an interelectrode distance of 20 µm, where the peripheral electrodes have a diameter of 20 µm and 30 µm. This type of HexaMEA (60HexaMEA-Ti, 60HexaMEA-ITO) provides no internal reference electrode.

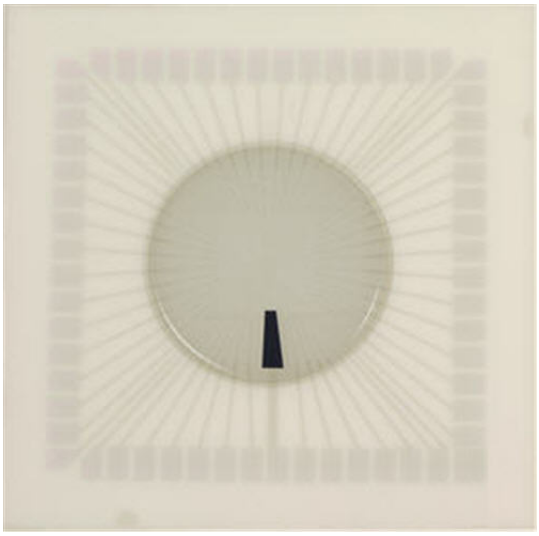
The electrodes of 60HexaMEA40/10iR-ITO are configured with invariable interelectrode distance of 40 µm, and with TiN electrodes of 10 µm diameter. They include a big internal reference electrode. The tracks and contact pads are made of ITO.

Using 60HexaMEAs

The same material is used for standard MEAs and HexaMEAs. Therefore, they are equally robust and heat-stabilized. They can be autoclaved and coated with different procedures for cell and tissue cultures.

4.5 Thin MEA: 60ThinMEA

60ThinMEA200/30iR-ITO, 60ThinMEA30/10iR-ITO



60ThinMEAs are only 180 µm "thick", ideally suited for high-resolution imaging. 60ThinMEAs are like standard MEAs, but the electrodes are embedded in a very thin and delicate glass substrate on a robust ceramic carrier. The thin glass allows the use of oil immersion objectives with a high numerical aperture.

Like standard MEAs, 59 electrodes and one reference electrode are arranged in an 8 x 8 layout grid with electrode diameters of 30 µm and interelectrode distances of 200 µm.

60ThinMEAs are also available in a double 5 x 6 layout grid with 10 µm TiN electrodes and 30 µm interelectrode distance like the High Dense MEA (60ThinMEA30/10iR-ITO).

The flat, round electrodes are made of titanium nitride (TiN).

Tracks and contact pads are made of transparent ITO; insulation material is silicon nitride.

Using 60ThinMEAs

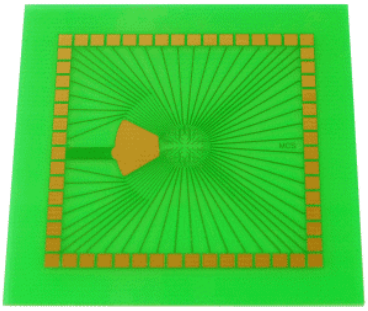
60ThinMEAs are heat-stabilized and can be autoclaved. They can also be coated with different procedures for cell and tissue cultures.

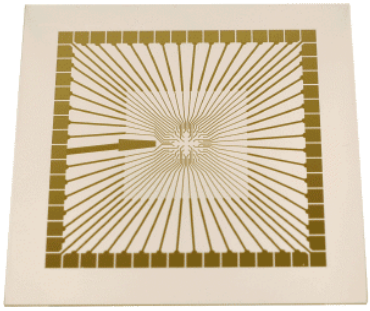
They should be handled with great care because of the thin and delicate recording area.

4.6 Eco MEA: 60EcoMEA

60EcoMEA, 60EcoMEA-Glass

60EcoMEAs are available on opaque printed circuit board (PCB) and on transparent glass base (60EcoMEA-Glass). They are low price variants for medium throughput applications like small screens where material costs play a bigger role than in more scientific MEA applications.





60EcoMEAs are opaque and are therefore useful only for applications where you do not need a visual control under a microscope, for example, for established cell cultures. 60EcoMEA-Glasses are transparent all-purpose MEAs.

Due to the special production process on PCB, electrodes of 60EcoMEAs are available only with a diameter of 100 µm and an interelectrode distance of 700 µm. The electrodes on 60EcoMEA-Glass also have a diameter of 100 µm and a distance of 700 µm. Thus, 60EcoMEA or 60EcoMEA-Glass are useful for applications where a high spatial resolution is not important, but which emphasize on low price consumables. They have proven to be especially useful for recordings from established cardiomyocyte cultures. They are not useful for establishing a new cell culture, as the cell performance cannot be monitored. Multi Channel Systems recommends to use standard 200/30 MEAs for establishing the cell culture first, then switch to 60EcoMEA or 60EcoMEA-Glass.

60EcoMEAs are provided in the typical 8 x 8 layout with internal reference electrode. Custom layouts following your personal specifications are possible at very reasonable prices. Please ask your local retailer for details. Electrodes, tracks, and contact pads are made of pure gold. Due to the soft gold material of the contact pads, the contact to the amplifier pins is excellent. The insulation material on EcoMEA-Glass chips is SU-8 (a photoresist, 1 - 2 µm)

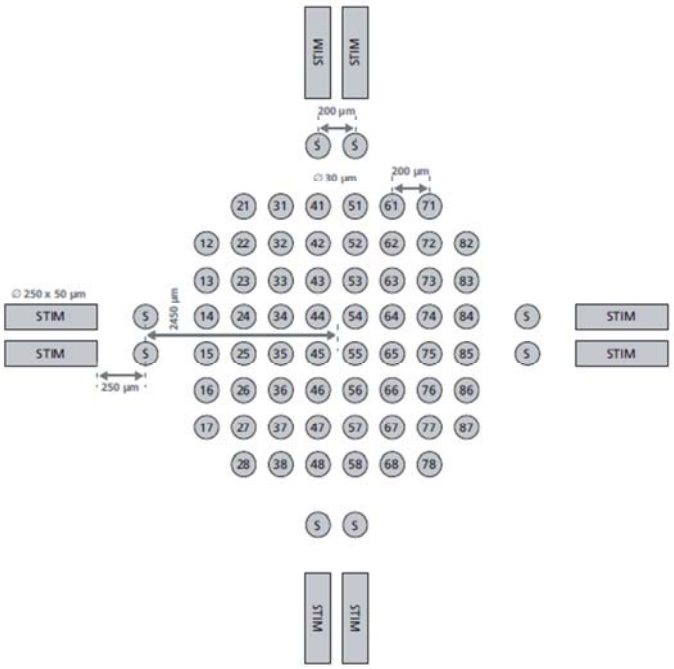
Using 60EcoMEAs

Like standard MEAs, 60EcoMEAs are very robust and heat-stabilized. They can be autoclaved and coated with different procedures for cell and tissue cultures. The gold electrodes are very robust, too, and are the only MEA electrodes that will endure more severe cleaning methods.

New 60EcoMEAs are very hydrophobic. They should be coated with nitrocellulose or treated with a plasma cleaner before use.

4.7 Stimulation MEA: 60StimMEA

60StimMEA200/30-Ti



Stimulation MEAs are available in 8 x 8 standard MEA layout with additional 16 stimulation electrodes. Eight pairs of the stimulation electrodes are big and square, the other eight pairs have the same size as the recording electrodes (30 µm). For perfect use with the MEA1060 amplifiers is it necessary to connect adapters: MEA-STIM-ADPT-INV-BC for MEA1060-Inv-BC amplifiers, MEA-STIM-ADPT-Up(BC) for MEA1060-Up(BC) amplifiers.

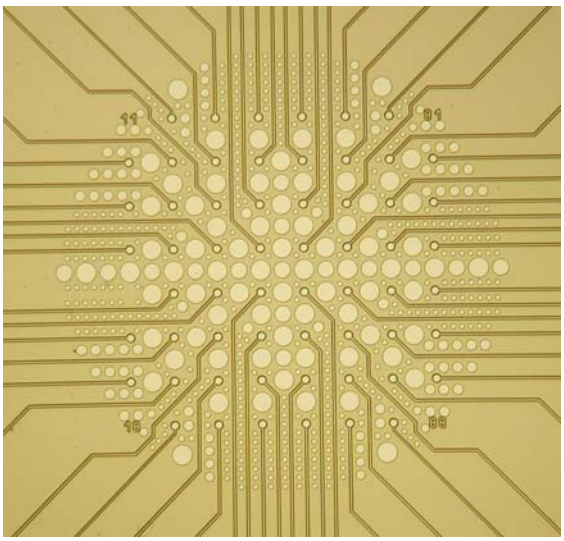
Stimulation MEAs are useful, for example, for pacing cardiac tissues like hESCM (human embryonic stem cells derived cardiac myocytes), that need higher voltages and durations than stimulation of neuronal tissues. So, the use of larger stimulating electrodes is recommended.

Using 60StimMEAs

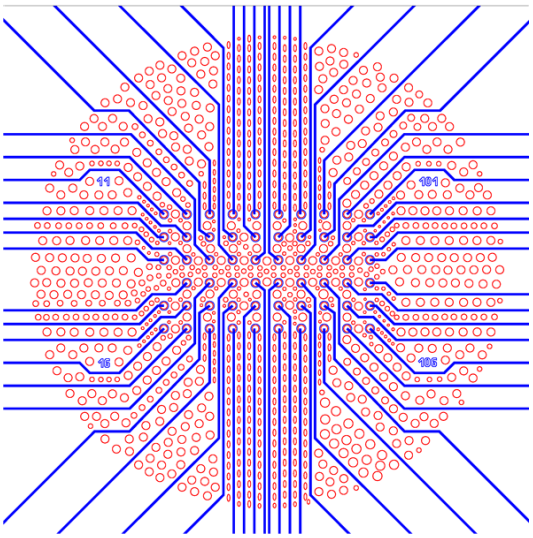
The same material is used for standard MEAs and 60StimMEAs. Therefore, they are equally robust and heat-stabilized. They can be autoclaved and coated with different procedures for cell and tissue cultures.

4.8 Perforated MEA: 60pMEA

60pMEA200/30iR-Ti



60pMEA100/30iR-Ti



Acute slice recordings on common glass MEAs are done from the cells at the bottom of the slice, which are in contact with the MEA electrodes. These cells get less oxygen and nutrients from the perfusion medium, and therefore are likely to give smaller signals and might eventually die first. Perforated MEAs present a solution to this problem as they allow a perfusion of the tissue from both sides at the same time, thereby optimizing the oxygen supply of the acute slice.

Perforated MEAs are identical in size and function to the regular MEAs. The recording electrodes are arranged in 8 x 8 standard layout grid in 60pMEA200/30iR-Ti, and in 6 x 10 layout grid in 60pMEA100/30iR-Ti. The electrodes are integrated into a thin polyimide foil. This thin foil is fixed on a ceramic or glass waver for mechanical stability. In the middle of the waver, under the electrode field, there is a hole that makes it possible to access the electrode field from below. The area around the electrodes is perforated to allow a perfusion of the tissue from both sides. The total area of the holes averages 0.8 mm, the diameters of the holes varies between 20 µm and 90 µm.

These pMEAs are designed for use with MEA2100-System headstages with perfusion element (PE) and MEA1060 amplifier equipped with a perfusion ground plate (PGP). The PE or PGP replaces the standard ground plate of the headstage or MEA1060 amplifier. Please note that there are different types of the MEA-PGPs for different amplifier types (MEA1060-UP-PGP, MEA1060-UP-BC-PGP, and MEA1060-INV / INV-BC-PGP). Additional to the use of 60pMEAs together with the MEA2100-(2x)60-System, you can use 120pMEAs with MEA2100-120-System equipped with a perfusion element (PE) integrated in the ground plate of the headstage.

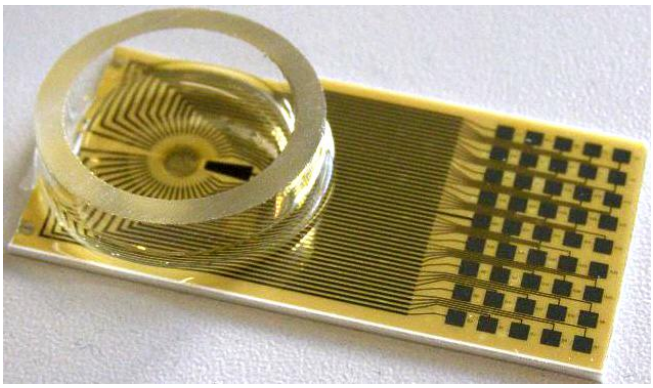
For an overview of suggested configurations to work with 60pMEAs, see the MEA Application Note "Acute Hippocampal Slices on pMEAs".

Using 60pMEAs

Perforated MEAs have a robust ceramic carrier or they are mounted on glass as usual, but the electrodes are embedded in polyimide foil. Therefore they are heat stable to 50 °C only, and cannot be autoclaved. Please do not use an ultrasonic bath for cleaning.

4.9 Perforated MEAs for Use with MEA2100-32-System and USB-MEA32-STIM4-System

pMEA-32S12-L1, pMEA-32S12-L2, pMEA-32S12-L3, pMEA-32S12-L4



pMEA-32S12-Lx

For the **USB-MEA32-STIM4-System** small perforated MEAs have been designed. Please see USB-MEA32-STIM4 manual for detailed information. Additionally the **MEA2100-32-System** is adapted for these small type of MEA. The pMEAs are different in size, but identical in function to the regular pMEAs. Layout 1 (pMEA-32S12-L1) of the perforated MEAs designed for the **MEA2100-32-** and for the **USB-MEA32-STIM4-System** has been optimized for acute hippocampal slices.

The flat, round electrodes are made of titanium nitride (TiN) with a diameter of 30 µm for the recording electrodes, and 50 µm for the stimulation electrodes. The stimulation electrodes can not be used for recording, and vice versa. The interelectrode distances vary from 150 to 200 µm. MEAs with titanium nitride (TiN) electrodes are very stable. Therefore, the pMEA can be reused several times and is perfect for long-time experiments (up to several weeks and even months). The electrode impedance ranges between 30 kΩ and 50 kΩ. Tracks and contact pads are made of titanium nitride (TiN), the insulation material is polyimide, respectively.

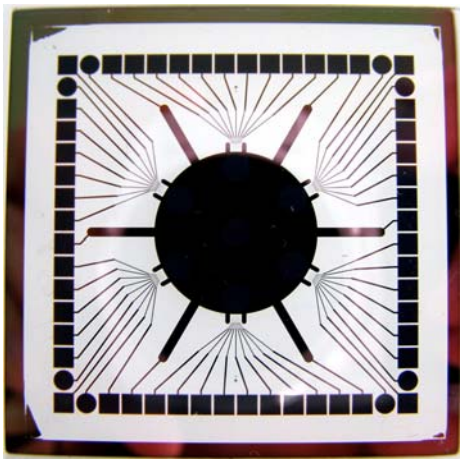
The electrodes are integrated into a thin polyimide foil. This thin foil is fixed on a ceramic waver for mechanical stability. In the middle of the waver, under the electrode field, there is a hole that makes it possible to access the electrode field from below. The area around the electrodes is perforated to apply suction to the slice from below. The total area of the holes averages 0.8 mm, the diameters of the holes varies from 20 to 90 µm. Please read chapter "Working with the USB-MEA32-STIM4 Amplifier" in USB-MEA32-STIM4 manual or “Setting up the MEA” in the MEA2100 manual.

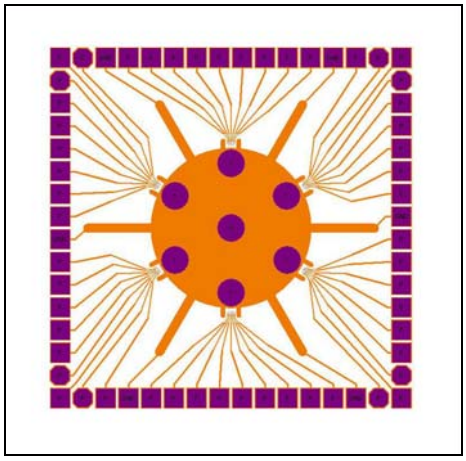
Using pMEAs

Perforated MEAs have a robust ceramic carrier, but the electrodes are embedded in polyimide foil. Therefore they are heat stable to 50 °C only, and cannot be autoclaved. Please do not use an ultrasonic bath for cleaning.

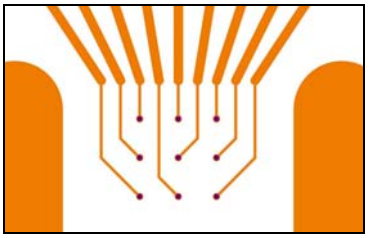
4.10 MEA with 6 Wells: 60-6wellMEA

60-6wellMEA200/30iR-Ti

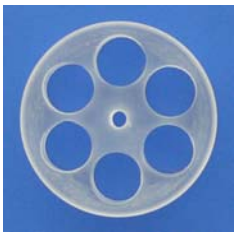


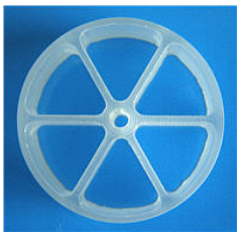


60-6wellMEAs are MEA chips with six independent culture chambers, separated by a macrolon ring. Inside each well, in between the marked two bars coming out of the circle in the middle of the MEA, there is a field of nine electrodes with an internal reference electrode. The electrode in the center of the MEA is for grounding.



60-6wellMEAs are developed, for example, for safety-pharmacological screenings of drug induced QT-prolongation. Multi Channel System MCS GmbH provides a software solution for these experimental intentions, the QT-Screen-Lite program. The 60-6wellMEA allows running six experiments with identical surrounding conditions at once. Two types of macrolon rings are available: Rings with six triangular chambers and rings with round chambers.





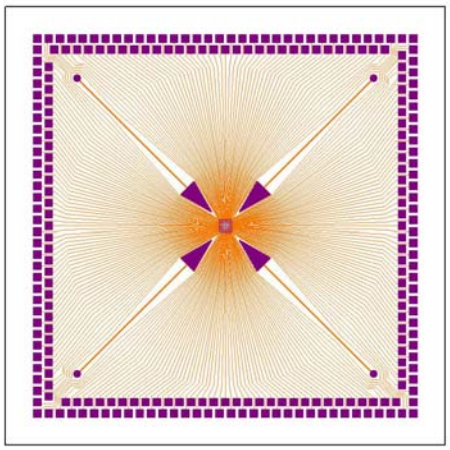
The electrodes of the 60-6wellMEA are from titanium nitride (TiN), the isolation is made up of Silicon nitride (SiN). Contact pads are from titanium nitride (TiN), and tracks are from titanium (Ti). The diameter of the electrodes is 30 µm, the distance from centre to centre is 200 µm.

Using 60-6wellMEAs

60-6wellMEAs can be used for a wide variety of applications. They are robust and heat-stabilized. They can be autoclaved and coated with different procedures for cell and tissue cultures. Generally, they can be used for acute experiments as well as long-term cultures.

4.11 256MEA for Use with USB-MEA256-System

256MEA30/8-ITO, 256MEA60/10iR-ITO, 256MEA100/30-ITO, 256MEA200/30-ITO, and 256ThinMEA



The 256MEAs have to be used with the USB-MEA256-System.
Please refer to the USB-MEA256-System manual for detailed information.

The 256MEA contains 252 recording, and four ground electrodes arranged in a 16 x 16 layout grid embedded in a transparent glass substrate. The contact to the amplifier is provided by a double ring of contact pads around the rim of the MEA. The standard material for MEAs is also used for 256MEAs: The electrodes are from titanium nitride (TiN) with a silicon nitride (SiN) isolator, and contact pads and tracks are made of transparent indium tin oxide (ITO).

The spacing of the electrodes in the 16 x16 grid averages 30, 60, 100 µm or 200 µm between the electrodes. The electrode diameter of 30 µm results in an impedance of approximately 30 - 50 kΩ. The electrode diameter of 10 µm results in an impedance of approximately 250 - 400 kΩ. The dimension of the glass carrier is 49 x 49 x 1 mm as usual. 256MEAs are stable in a temperature range from 0 ° - 125 °C.

The 256MEA is only MEA type, which is rotationally symmetric.

256ThinMEAs are only 180 µm "thick", ideally suited for high-resolution imaging. 256ThinMEAs are like standard MEAs, but the electrodes are embedded in a very thin and delicate glass substrate on a robust ceramic carrier. The thin glass allows the use of oil immersion objectives with a high numerical aperture.

Like 256MEAs, 252 electrodes are arranged in a 16 x 16 layout grid with electrode diameter of 30 µm, and interelectrode distance of 200 µm (256ThinMEA200/30-ITO).

Using 256MEAs

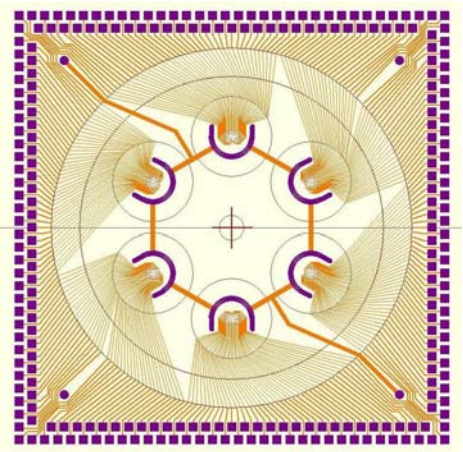
The same material is used for standard MEAs and 256MEAs. Therefore, they are equally robust and heat-stabilized. They can be autoclaved and coated with different procedures for cell and tissue cultures.

Using 256ThinMEAs

256ThinMEAs are heat-stabilized and can be autoclaved. They can also be coated with different procedures for cell and tissue cultures. They should be handled with great care because of the thin and delicate recording area.

4.12 MEA with 6 Wells for Use with USB-MEA256-System

256-6wellMEA200/30iR-Ti



The 256-6wellMEA200/30iR-ITO has 256 electrodes and has to be used with the USB-MEA256-System. Please refer to the USB-MEA256-System manual for detailed information.

The dimension of the glass carrier is 49 x 49 x 1 mm as usual. The MEAs with 6 wells are stable in a temperature range from 0 ° - 125 °C.

The 256-6wellMEA contains 252 recording, 6 reference and four ground electrodes arranged in 6 electrode blocks with a 6 x 7 layout grid for the recording electrodes. The reference electrode is around each block. They are embedded in a transparent glass substrate. The contact to the amplifier is provided by a double ring of contact pads around the rim of the MEA. The standard material for MEAs is also used for 256-6wellMEA: The electrodes are from titanium nitride (TiN) with a silicon nitride (SiN) isolator, and contact pads and tracks are made of transparent indium tin oxide (ITO).

Using the 256-6wellMEA with macrolon ring, you have six separate culture chambers on one MEA, for example, for drug application in a screening experiment.

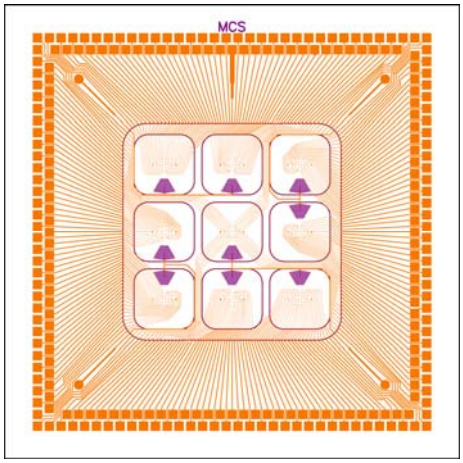
The spacing between the recording electrodes in the 6 x 7 grid averages 200 µm between the electrodes. The electrode diameter of 30 µm results in an impedance of approximately 30 - 50 kΩ.

Using 256-6wellMEAs

The same material is used for standard MEAs and 256-6wellMEAs. Therefore, they are equally robust and heat-stabilized. They can be autoclaved and coated with different procedures for cell and tissue cultures.

4.13 MEA with 9 Wells for Use with USB-MEA256-System

256-9wellMEA300/30iR-ITO



The 256-9wellMEA300/30iR-ITO has 256 electrodes and has to be used with the USB-MEA256-System. Please refer to the USB-MEA256-System manual for detailed information.

The dimension of the glass carrier is 49 x 49 x 1 mm as usual. The MEAs with 9 wells are stable in a temperature range from 0 ° - 125 °C.

The 256-9wellMEA contains 234 recording, 18 stimulation or recording, and four ground electrodes arranged in nine electrode blocks with a 6 x 5 layout grid for the recording electrodes, two stimulation or recording electrodes, and one reference electrode per each block. They are embedded in a transparent glass substrate. The contact to the amplifier is provided by a double ring of contact pads around the rim of the MEA. The standard material for MEAs is also used for 256-9wellMEA: The electrodes are from titanium nitride (TiN) with a silicon nitride (SiN) isolator, and contact pads and tracks are made of transparent indium tin oxide (ITO).

Using the 256-9wellMEA with macrolon quadrate, you have nine separate culture chambers on one MEA, for example, for drug application in a screening experiment.

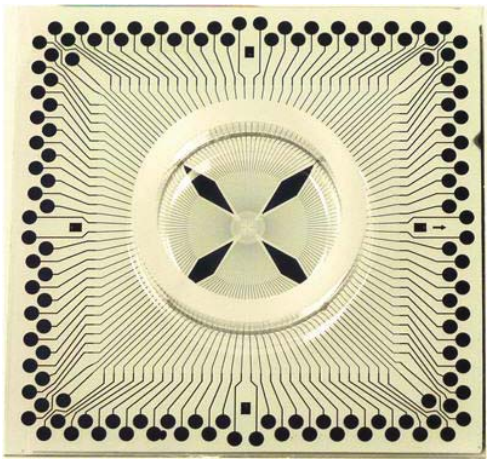
The spacing between the recording electrodes in the 6 x 5 grid averages 300 µm between the electrodes. The electrode diameter of 30 µm results in an impedance of approximately 30 - 50 kΩ. The dimension of the square stimulation electrode is 50 x 200 µm.

Using 256-9wellMEAs

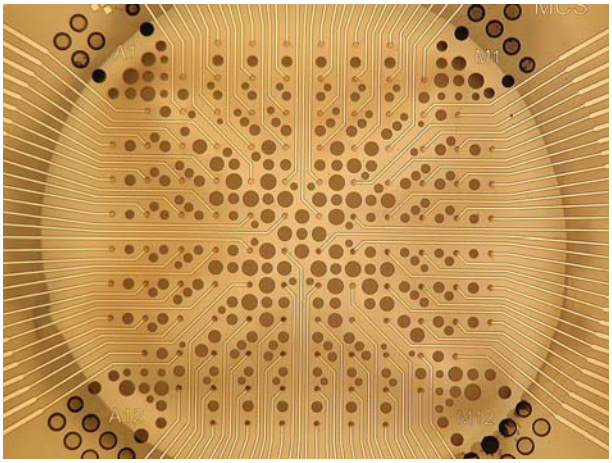
The same material is used for standard MEAs and 256-9wellMEAs. Therefore, they are equally robust and heat-stabilized. They can be autoclaved and coated with different procedures for cell and tissue cultures.

4.14 120MEA with for Use with MEA2100-120-System

120MEA200/30iR-Ti, 120MEA100/30iR-Ti, 120pMEA200/30iR-Ti



120MEA200/30iR-Ti



120pMEA200/30iR-Ti (electrode field with perforation)

The 120MEA200/30iR-Ti has 120 electrodes and can only be used with the MEA2100-System connected to a headstage HS120 with 120 electrodes. Please refer to the MEA2100-System manual for detailed information.

The dimension of the glass carrier is 49 x 49 x 1 mm as usual. The MEAs with 120 electrodes are stable in a temperature range from 0 ° - 125 °C.

The 120MEA200/30iR-Ti contains 120 recording, four reference and four ground electrodes arranged in a 12 x 12 layout grid. They are embedded in a transparent glass substrate. The contact to the amplifier is provided by a double ring of contact pads around the rim of the MEA. The standard material for MEAs is also used for 120MEA200/30iR-Ti: The electrodes are from titanium nitride (TiN) with a silicon nitride (SiN) isolator, and contact pads and tracks are made of titanium nitride (TiN).

The spacing between the recording electrodes in the 12 x 12 grid averages 100 or 200 µm between the electrodes. The electrode diameter of 30 µm results in an impedance of approximately 30 - 50 kΩ.

This MEA is also available as perforated 120pMEA200/30iR-Ti. The electrodes are from Titan Gold Titan, all other MEA parameters are the same. The inner diameter around the electrodes of 3 to 4 mm^2 is perforated and the total area of holes is 12 % of these area.

Using 120MEAs

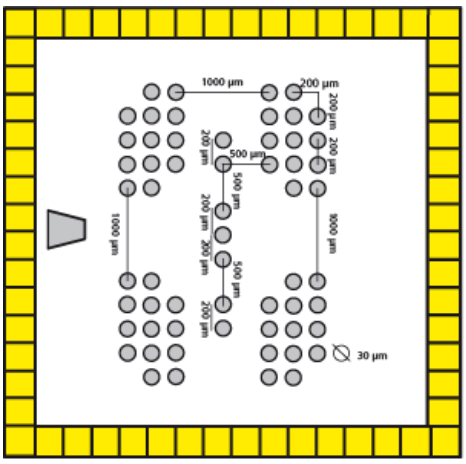
The same material is used for standard MEAs and 120MEA200/30iR-Ti and 120MEA100/30iR-Ti. Therefore, they are equally robust and heat-stabilized. They can be autoclaved and coated with different procedures for cell and tissue cultures.

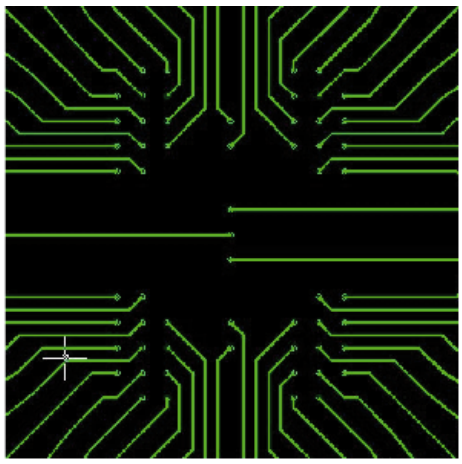
Using 120pMEA200/30iR-Ti

Perforated MEAs have a glass carrier, but the electrodes are embedded in polyimide foil. Therefore they are heat stable to 50 °C only, and cannot be autoclaved. Please do not use an ultrasonic bath for cleaning.

4.15 Quadrant MEA: 60-4QMEA1000

60-4QMEA1000iR-Ti





The 60-4QMEA1000 has 60 electrodes organized in four quadrants (13 electrodes each) with a center line (7 electrodes). The electrode diameter is 30 µm, and the interelectrode distance varies: Inside the quadrants the distance is 200 µm, from quadrant to quadrant the distance is 1000 µm, and to the center line it is 500 µm.

The 60-4QMEA1000 is available with an internal reference electrode.

The flat, round electrodes are made of titanium nitride (TiN). MEAs with TiN electrodes are very stable. Therefore, the MEAs can be reused several times and are perfect for long-time experiments (up to several weeks and even months). The electrode impedance ranges between 30 kΩ and 50 kΩ.

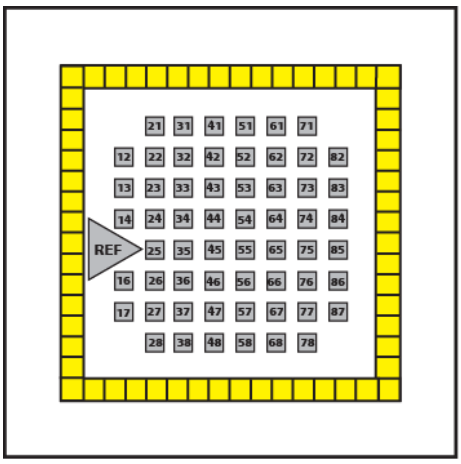
Tracks are made of titanium (Ti) and contact pads are made of titanium nitride (TiN); insulation material is silicon nitride (SiN).

Using 60-4QMEA1000

The 60-4QMEA1000 can be used for a wide variety of applications. They are robust and heat-stabilized. They can be autoclaved and coated with different procedures for cell and tissue cultures. Generally, they can be used for acute experiments as well as long-term cultures.

4.16 Square MEA: 60SquareMEA

60SquareMEA200/50iR-Ti



60SquareMEAs have 60 electrodes in an 8 x 8 layout grid with square electrode of 50 x 50 µm size and interelectrode distances of 200 µm. They are available with an internal reference electrode. You can connect the internal reference electrode directly to the amplifier's ground and will not need silver pellets for grounding the bath anymore.

The flat, square electrodes are made of titanium nitride (TiN). The electrode size of 50 x 50 µm guarantees very low noise. MEAs with TiN electrodes are very stable. Therefore, the MEAs can be reused several times and are perfect for long-time experiments (up to several weeks and even months). The electrode impedance ranges about 30 kΩ.

Tracks are made of titanium (Ti) and contact pads are made of titanium nitride (TiN); insulation material is silicon nitride.

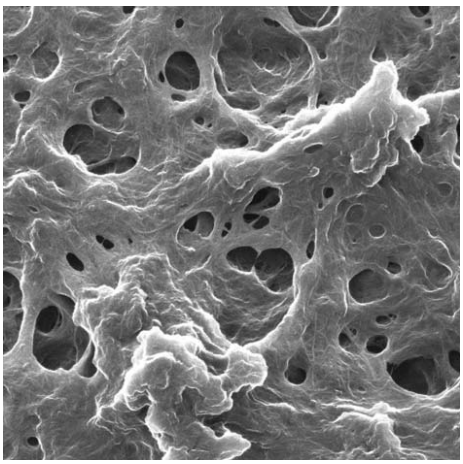
Important: MEAs are not symmetrical! That is, why the **writing** (for example NMI, LEITER, MEA type) on the MEA chip should be on the right side viewed from the front, with the sockets of the amplifier in the back. MEAs with one big internal reference electrode should be placed with reference electrode to the left side in the amplifier. Otherwise, the MEA layout will not match with the pin layout of the channel map in the data acquisition program.

Using 60SquareMEAs

MEAs with square electrodes can be used for a wide variety of applications. They are robust and heat-stabilized. They can be autoclaved and coated with different procedures for cell and tissue cultures. Generally, they can be used for acute experiments as well as long-term cultures.

4.17 PEDOT-CNT MEAs: 60PedotMEA

60PedotMEA200/30iR-Au



Carbon nanotube stucture of PEDOT electrodes.

60PedotMEAs have - like standard MEAs - 59 electrodes and one reference electrode that are arranged in an 8 x 8 layout grid with electrode diameters of 30 µm and interelectrode distances of 200 µm.
The flat, round electrodes are made of PEDOT-CNT carbon nanotube – poly 3,4-ethylene-dioxythiophene.

Contact pads and track material is made of titanium nitride (TiN) covered by a layer of gold (Au).
The insulation material is silicon nitride.

This type of MEA is characterized by very low impedance values of approximately 20 kΩ.They are ideal for stimulation and have excellent biocompatibility and cell adhesion.

Important: MEAs are not symmetrical! That is, why the **writing** (for example NMI, LEITER, MEA type) on the MEA chip should be on the right side viewed from the front, with the sockets of the amplifier in the back. MEAs with one big internal reference electrode should be placed with reference electrode to the left side in the amplifier. Otherwise, the MEA layout will not match with the pin layout of the channel map in the data acquisition program.

Using 60PedotMEAs

MEAs with PEDOT-CNT electrodes can be used for a wide variety of applications. They are robust and heat-stabilized. They can be autoclaved and coated with different procedures for cell and tissue cultures. Generally, they can be used for acute experiments as well as long-term cultures.

4.18 FlexMEA

FlexMEAs are made of flexible polyimide foil, perfect for *in vivo* and specific *in vitro* applications. Only 12 µm "thick" and weighing less than 1 g, the FlexMEA biosensor is very thin and light weight.

The FlexMEAs are available with 32 (64) recording electrodes plus two (four) indifferent reference electrodes and two (four) ground electrodes in a 6 x 6 (8 x 9) electrodes grid. More layouts can be provided on request. The flexible base is perforated for a better contact with the surrounding tissue.

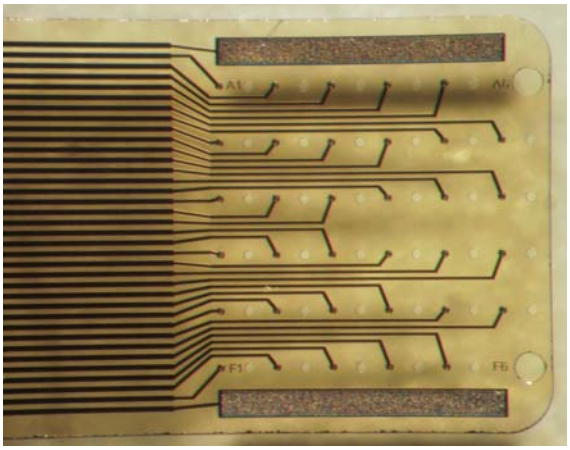
The electrodes are from titanium nitride (TiN), contact pads and track material from pure gold. FlexMEAs are stable at a temperature range from 10 °C to 125 °C and can be autoclaved.

Using FlexMEAs

Warning: Do not use an ultrasonic bath for cleaning. The manufacturer recommends sterilization by rinsing with alcohol.

FlexMEAs are usually connected to a head stage preamplifier that is connected to a filter amplifier or programmable gain amplifier (see also the ME-System product line of Multi Channel Systems). Via provided adapters FlexMEAs can be connected to 32-channel miniature preamplifiers MPA32I from Multi Channel Systems for *in vivo* experiments. There is no need for an adapter if the FlexMEA should be connected to the 32-channel miniature preamplifier MPA32I-Flex.

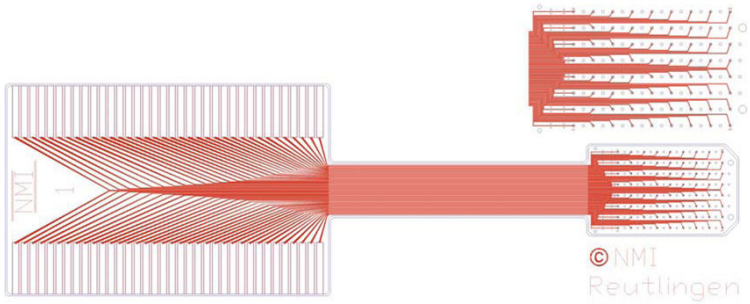
FlexMEA36



The FlexMEA36 has 32 recording electrodes plus two internal reference electrodes and two ground electrodes in a 6 x 6 electrodes grid. The titanium nitride electrodes have a diameter of 30 µm, and the distance between the electrodes is 300 µm. The polyimide foil is perforated with holes of 30 µm diameter, ensuring optimal tissue contact.

When using the FlexMEA36 together with a standard 32-channel miniature preamplifier MPA32I, you need the ADPT-FM-32 adapter to connect the FlexMEA36 to the standard MPA32I. There is no need for an adapter if you use the FlexMEA36 specified 32-channel miniature preamplifier MPA32I-Flex. Please read the data sheet FlexMEA36, and the MPA32I (-Flex) manual for more information.

FlexMEA72



The FlexMEA72 has 64 recording electrodes plus four internal reference electrodes and four ground electrodes in a 8 x 9 electrodes grid. The titanium nitride electrodes have a diameter of 100 µm, and the distance between the electrodes is either 625 µm or 750 µm. The polyimide foil is perforated with holes of 100 µm diameter, ensuring optimal tissue contact.

When using the FlexMEA72 together with two standard 32-channel miniature preamplifier MPA32I, you need the ADPT-FM-72 adapter to connect the FlexMEA72 to two standard MPA32Is. Please read the data sheet FlexMEA72 or ADPT-FM-72, and the MPA32I manual for more information.

4.19 EcoFlexMEA

EcoFlexMEAs are made of flexible polyimide (Kapton). They are less flexible as FlexMEAs, but therefore more robust in handling and sterilization. With a thickness of 50 µm and low weight the EcoFlexMEA is perfect for *in vivo* and specific *in vitro* applications, respectively.

The EcoFlexMEA is available with 24 or 36 electrodes, two internal reference electrodes, and two ground electrodes. Custom layouts can be provided on request.

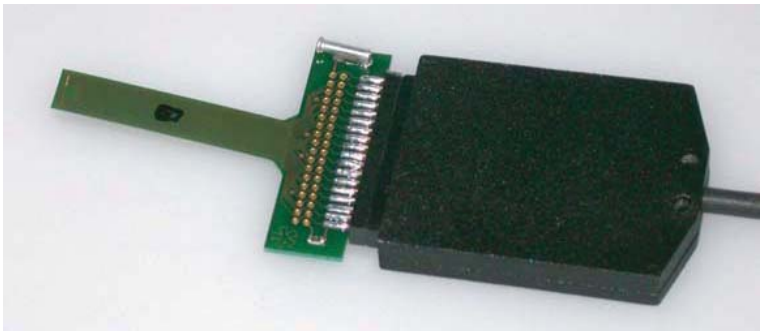
The electrodes, contact pads and track material are made of pure gold. EcoFlexMEAs are stable at a temperature range from 0 °C to 125 °C and can be autoclaved.

The EcoFlexMEA can directly be connected to a standard 32-channel miniature preamplifier MPA32I, you do not need an adapter. An additional connector on the side of the EcoFlexMEA36 can be used for connecting a silver pellet or a silver wire for grounding the bath. Please read the data sheet EcoFlexMEA, and the MPA32I manual for more information.

Using EcoFlexMEAs

EcoFlexMEAs are usually connected to a head stage preamplifier that is connected to a filter amplifier or programmable gain amplifier (see also the ME-System product line of Multi Channel Systems). EcoFlexMEAs can be directly connected to a 32-channel miniature preamplifier from Multi Channel Systems for *in vivo* experiments.

EcoFlexMEA36



The EcoFlexMEA36 has 32 recording electrodes, two internal reference electrodes, and two ground electrodes in a 6 x 6 electrode grid. The recording electrodes have a diameter of 50 µm, the distance between the electrodes from center to center is 300 µm. The electrodes, contact pads and track material are made of pure gold. EcoFlexMEA36 is stable at a temperature range from 0 °C to 125 °C and can be autoclaved.

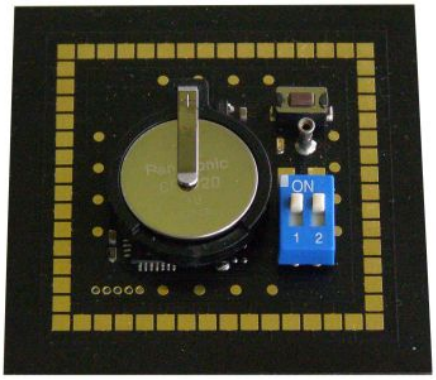
The EcoFlexMEA36 can directly be connected to a standard 32-channel miniature preamplifier MPA32I, you do not need an adapter. The connector on the right side of the MEA (see picture) can be used for connecting a silver pellet or a silver wire for grounding the bath. Please read the data sheet EcoFlexMEA36, and the MPA32I manual for more information.

EcoFlexMEA24

The EcoFlexMEA24 has 24 recording electrodes, two internal reference electrodes, and two ground electrodes in a 2 x 10 + 4 electrode grid. The recording electrodes have a diameter of 80 µm, the distance between the electrodes from center to center is 300 µm. The electrodes, contact pads and track material are made of pure gold. EcoFlexMEA36 is stable at a temperature range from 0 °C to 125 °C and can be autoclaved.

The EcoFlexMEA36 can directly be connected to a standard 32-channel miniature preamplifier MPA32I, you do not need an adapter. Please read the data sheet EcoFlexMEA24, and the MPA32I manual for more information.

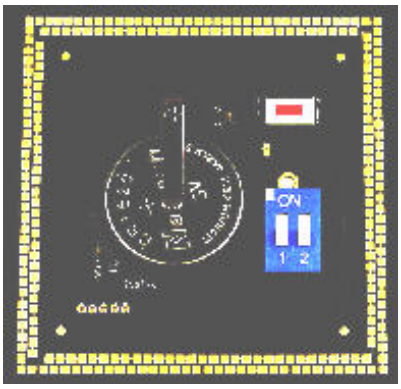
4.20 MEA Signal Generator: 60MEA-SG



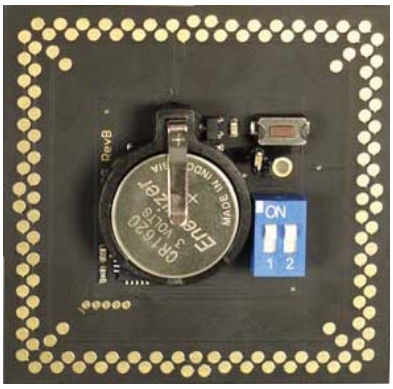
60MEA-SG

The 60MEA-Signal Generator is a convenient tool for MEA-Systems first time users. It can replace a MEA for learning and / or teaching purposes. The device has the same dimensions and contact pad layout as a 60-channel MEA chip, and is compatible with all MEA1060 amplifier types and with the MEA2100-System with 60-channel headstage, MEA2100-HS60 or MEA2100-HS2x60.

The **MEA-SG** produces sine waves, or replays a variety of biological signals. These signals are fed into the MEA amplifier as analog signals. With this artificial data, you are able to test the functionality of the hardware and software system, without the need for a biological sample on a real MEA. Please use the 256MEA-SG for the USB-MEA256-System and the 120MEA-SG for MEA2100-System connected to a headstage with 120 channels, the MEA2100-HS120.

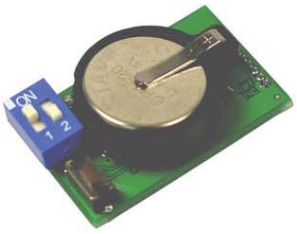


256MEA-SG



120MEA-SG

For FlexMEAs, connected to ME-Systems and for wireless headstages, connected to the Wireless-System you can use a specially adapted signal generator ME/W-SG.



ME/W-SG

5 MEA Handling

Warning: If possible, use only liquids or cleaning solutions with a neutral pH = 7 on MEAs. Do not expose MEAs with a silicon nitride insulation or TiN electrodes to basic liquids (pH > 7) or aggressive detergents for a longer period of time. Basic or aggressive liquids may damage TiN electrodes irreversibly.

Warning: It is absolutely necessary to rinse the MEAs thoroughly with distilled water after treatment with detergent, particular when using Terg-A-Zym before heat sterilization (dry heat sterilization is not recommended). Otherwise the potential rests of the detergent may burn into the glass carrier of the MEA and may destroy the electrodes.

Warning: Do not touch the electrode field in any way during the coating or cleaning procedure. Keep all instruments, tissues, pipette tips, and similar at a safe distance from the recording area. The electrodes are easily damaged (except EcoMEA electrodes).

5.1 Hydrophilic Surface Treatment

The surface of new MEAs is hydrophobic, and even hydrophilic MEAs tend to become hydrophobic again during storage. A hydrophobic surface prevents attachment and growth of the (hydrophilic) cells. The first step in preparing a MEA for use is therefore to ensure that the surface is hydrophilic enough for coating and cell adhesion.

To test this without contaminating the surface, place a small drop of water on the MEA surface outside the culture chamber. If the drop does not wet the surface, you likely need to perform one of the following steps, in particular when using new arrays.

Literature

Ulrich Egert, Thomas Meyer (2004); Heart on a Chip — Extracellular multielectrode recordings from cardiac myocytes *in vitro*, "Methods in Cardiovascular Research", S. Dhein and M. Delmar (eds.)

5.1.1 Plasma Cleaning

Laboratories with access to electron microscopy facilities are likely to have a sputter device or a plasma-cleaning chamber (for example Plasma Technology, Herrenberg, Germany or PDC-32G from Harrick Plasma, Ithaca, NY, United States). MEAs can be treated in these chambers with low vacuum plasma for about two minutes. The MEA surface is exposed to a gas plasma discharge, which will make the surface polar and thus more hydrophilic. The treatment gives a very clean and sterile surface that can be coated readily with water-soluble molecules. Note that the effect wears off after a few days.

5.1.2 Protein Coating

If protein coating is acceptable in the planned experiments, there is another quick and simple way to render the surface hydrophilic.

1. Sterilize the MEAs as described below.
2. Place approximately 1 ml of a concentrated, sterile protein solution (for example, albumin, fetal calf serum or similar) onto the culture region for about 30 min.
3. Wash the culture chamber thoroughly with sterile water afterwards. The MEA can then be directly used for cell culture.

5.1.3 Preculturing

Another pragmatic method is to coat the hydrophobic MEAs and to plate the cell cultures on the MEA, and let it grow for some days (up to weeks) until the cells have transformed the surface so that it is sufficiently hydrophilic. The "preculture" will generally show very bad growth and viability, and needs to be discarded before plating the culture that will be used for experiments.

Please note that the MEA and the electrode performance may suffer under cell culturing. Therefore, the above-mentioned methods are preferable.

5.2 Sterilization

Sterilization of MEAs is not necessary for acute slices.

Glass MEAs with TiN electrodes and EcoMEAs with gold electrodes can be sterilized with standard methods for cell culture materials using either rinsing with **70 % alcohol**, **UV-light** (about half an hour depending on the intensity), **vapor autoclavation**, or **dry-heat sterilization** up to a temperature maximum of 125 °C.

Warning: Do not autoclave or sterilize perforated MEAs by heat**.** These MEA types are not thermo-resistant, and will be irreversibly damaged.

5.2.1 Sterilization with Ethanol and UV Light

→ **Rinse** MEAs with 70 % ethanol. Do not immerse the MEA into the alcohol for a longer time otherwise the ring on the MEA will probably get off.

→ Let MEAs air-dry over night on a sterile workbench (laminar flow hood) with UV light turned on.

5.2.2 Steam Sterilization (Autoclavation)

→ Autoclave MEAs at 125 °C for 15 min.

5.2.3 Dry-Heat Sterilization

Dry-heat sterilization is possible if a stream autoclave is not available, which is the better choice. Please clean the MEA thoroughly with distilled water before using the oven, otherwise potential rests of any material may burn into the glass carrier of the MEA and may destroy the electrodes.

→ Thermally sterilize **MEAs** in an oven at **121 °C** for 15 min.

→ Thermally sterilize **FlexMEAs** in an oven at **121 °C** for 15 min.

→ Thermally sterilize **pMEAs** in an oven at **50 °C** for 2 hours.

5.2.4 Sterilization with Hot Water

→ Expose MEAs to hot water (90 °C) for 1 min.

5.3 MEA Storage

To maintain a hydrophilic surface after hydrophilization, it is recommended to store the MEAs filled with water until use. Dry MEAs will get hydrophobic again after some time.

Store MEAs filled with sterile distilled water at 4 °C in the dark (that is, in the fridge, to prevent microbiological contaminations) to maintain a hydrophilic surface.

5.4 MEA Coating

Coating of MEAs with various materials is used for improving the attachment and growth of cell cultures or cultured slices. Coating is generally not required for recordings from acute slices.

Coating of MEAs has the same purpose than coating of other culture dishes. Therefore, you can generally use the same standard protocols that you have established for coating culture dishes for your cell cultures, provided that the involved chemicals are not aggressive and damage the electrodes (see recommendations for the various MEA types).

In the following, some standard coating procedures are shortly described. You should try out which coating procedure proves best for your application. The listed materials are only recommendations; you may use any equivalent equipment. Most coatings are stable for several uses of the MEA and do not have to be removed after use (except nitrocellulose).

Please note that the materials and procedures described in the following are only a summary of published information from other sources (see references) or from personal communications with MEA users, and has the intention of helping users finding the appropriate information for setting up their experiments. Multi Channel Systems MCS GmbH has not tested or verified this information, and therefore cannot guarantee that the information is correct. Please refer to the referenced literature for planning and executing any experiments.

5.4.1 Coating with Nitrocellulose

Coating with nitrocellulose is a fast procedure that works with several cell types and tissues and that is also successful with slightly hydrophobic MEAs. This method has the advantage that the cells stick well to the surface. Nitrocellulose does not form a uniform layer on the MEA. The coating leaves patches of nitrocellulose, which serve as a glue for the tissue, on the MEA surface. The tissue is not likely to get detached even under severe mechanical disturbance (by perfusion, for example). MEAs coated with nitrocellulose can be stored for a few days. Nitrocellulose coating has to be removed after use.

Main advantages of this method are that nitrocellulose is cheap, coating is fast and easy, and it is also easily removed after use.

Note: Nitrocellulose solutions cannot be stored for a longer period of time. The solution forms a visible gelatinous precipitate after extended storage of at least half a year and will not produce satisfactory adhesive coatings anymore. Prepare a fresh solution if there are visible precipitates.

Materials

- Protran or other standard nitrocellulose membrane (Whatman, PerkinElmer)
- 100 % Methanol (Carl Roth GmbH + Co. KG, UN-No. 1230)

Nitrocellulose solution

→ For preparing a stock solution, dissolve a piece of 1 cm² nitrocellulose membrane in 10 ml methanol. Stock solutions may be stored at room temperature in polystyrene tubes. For the working solution, dilute the stock solution 10 : 1 with methanol. You can adjust the concentration to meet your requirements.

Procedure

1. Directly before use, pipette 3 – 5 µl of the working solution onto the recording field. The recording field should be completely covered.
2. Remove the coating solution and let the MEA air-dry. It takes just a few seconds for the methanol to evaporate.

Literature

Ulrich Egert, Thomas Meyer (2004); Heart on a Chip — Extracellular multielectrode recordings from cardiac myocytes *in vitro*, "Methods in Cardiovascular Research", S. Dhein and M. Delmar (eds.)

5.4.2 Coating with Polyethyleneimine (PEI) plus Laminin

Polyethyleneimine (PEI) has been successfully employed for dissociated cell cultures and proven to enhance cell maturation in culture compared to polylysine coated plates. Polyethyleneimine is a positively charged polymer and thus changes the charge on the glass surface from negative to positive. The tissue sticks even better with this method than with the nitrocellulose method, but the polyethylenimine forms a uniform layer that can get more easily detached from the surface, for example, by the perfusion. This coating method can optionally be combined with laminin.

Materials

- Poly(ethyleneimine) solution (PEI) (Sigma-Aldrich, Inc., P3143)
- Boric acid, crystalline (Fisher Scientific, A73-500)
- Borax (sodium tetraborate) (Sigma-Aldrich, Inc., B0127)
- 1 N HCl
- Laminin, 1mg/ml (Sigma-Aldrich, Inc., L2020)

Borate buffer

- 3.10 g boric acid
- 4.75 g borax

→ Dissolve in 1l distilled water at 80 °C.

→ Adjust pH to 8.4 with 1 N HCl.

PEI stock solution

0.05 – 0.1 % PEI dissolved in borate buffer.

Laminin solution

20 µg/ml laminin in plating medium.

Procedure

Note: It is necessary to thoroughly rinse off unbound PEI from the plates before use, as dried PEI is toxic.

1. Pipette 500 µl PEI solution onto the MEA. The recording field should be completely covered.
2. Incubate at RT for 1 h, or at 4 °C over night.
3. Remove the PEI solution and thoroughly rinse 4 x with distilled water.
4. Air-dry the MEA.
5. Sterilize with UV light for at least 1 h after coating.
6. (Place a drop of sterile laminin solution onto the MEA and incubate for 30 min. Aspirate, do not rinse, and directly seed your cells. Alternatively, mix the cells with laminin solution before plating.)

Literature

Ulrich Egert, Thomas Meyer (2004); Heart on a Chip — Extracellular multielectrode recordings from cardiac myocytes *in vitro*, "Methods in Cardiovascular Research", S. Dhein and M. Delmar (eds.)

Lelong, IH, et al. (1992); J. Neurosci. Res. 32:562-568

5.4.3 Coating with Polyornithine (plus Laminin)

Poly-D-lysine can be used as an alternative for polyornithine.

Materials

- Polyornithine
- Laminin, 1mg/ml (Sigma-Aldrich, Inc., L2020)

Polyornithine solution

→ 500 µg/ml polyornithine in distilled water

Laminin solution

→ 5 µg/ml laminin in plating medium or PBS (phosphate buffered saline).

Procedure

1. Incubate the MEA with polyornithine solution at RT for 2 – 3 hours or overnight at 4 °C.
2. Aspirate the polyornithine solution and rinse the MEA 3 x with distilled water before direct use or before the following coating with laminin. MEAs coated with polyornithine can be stored at 4 °C for several weeks.
3. Incubate pre-coated MEA with laminin solution for at least 1 h.
4. Aspirate the laminin solution and directly plate cells.

Literature

Cellular Neurobiology, A practical approach, ed. By Chad and Wheal, IRL Press, Oxford

5.4.4 Coating with Poly-D-Lysine (plus Laminin)

Poly-D-lysine has been used by several groups. Results seem to be equivalent to a coating with polyornithine. Some users complained about **cell clumping** and resulting cell death when using poly-D-lysine and had better results when using polyethylenimine (PEI).

Materials

- Poly-D-lysine 5 mg / 10 mL (= 0.05 % w/v) stock solution (Sigma-Aldrich, Inc., P7280)
- Laminin solution 1 mg/ml (Sigma-Aldrich, Inc., L2020)

Laminin solution

→ 20 µg/ml laminin in plating medium or PBS (phosphate buffered saline).

Procedure

1. Incubate the MEA with poly-D-lysine solution and incubate at 4 °C over night.
2. Rinse MEA with sterile distilled water 3x to remove toxic unbound lysine and let the MEAs air dry under sterile conditions (laminar flow) before plating the cells, or before the following coating with laminin. MEAs can be stored at 4 °C for up to two weeks.
3. Incubate pre-coated MEA with laminin solution at 4 °C over night.
4. Aspirate the laminin solution and directly plate the cells.

Literature

Goslin et al., 1988, Nature 336, 672-674

Maeda et al., 1995, J.Neurosci. 15, 6834-6845

Gross et al., 1997, Biosensors & Bioelectronics 12, 373-393

5.4.5 Coating with Poly-D-Lysine (plus Fibronectin)

This coating method is used, for example, for culturing dissociated suprachiasmatic nucleus (SCN) neurons (on standard 60MEA200/30). It is very stable and therefore especially useful for long-term cultures.

Materials

- Poly-D-lysine 5 mg / 10 mL (= 0.05 % w/v) stock solution (Sigma-Aldrich, Inc., P7280)
- Fibronectin (BD BioCoat™ Fibronectin Cellware) (BD Biosciences)

Fibronectin solution

→ Prepare a stock solution of 25 µg/ml fibronectin in distilled water or PBS (phosphate buffered saline) and store it at 4 °C.

Poly-D-Lysine plus fibronectin solution

→ Prepare a 0.01 % (w/v) poly-D-lysine solution, and add fibronectin 1 : 1 (resulting in a final concentration of 12.5 µg/ml).

Procedure

1. Pipette 10 µl of the poly-D-lysine plus fibronectin solution onto the recording field. Pipette about 50 µl of sterile distilled water near the rim of the culture chamber.
2. Incubate for 1 h in an incubator set to 35 °C, 65 % relative humidity, 9 % O_2 , 5 % CO_2 ; or 37 °C, 100 % humidity, 5 % CO_2. To avoid a dry out of the liquid, place the MEA in a big Petri dish with lid on.
3. Rinse 2 x with sterile distilled water.
4. Let MEAs air-dry over night on a sterile workbench (laminar flow) with UV light turned on.

5.4.6 Coating with Fibronectin

Fibronectin is a more biological coating alternative, especially used for heart tissues. The adhesion tends to be very stable, which allows longer cultivation times.

Materials

- Fibronectin (BD BioCoat™ Fibronectin Cellware) (BD Biosciences)

Fibronectin solution

→ Prepare a stock solution of 1 mg/ml fibronectin in distilled water or PBS (phosphate buffered saline) and store it at 4 °C. The stock solution is diluted with water or PBS to a final concentration of 10 µg/ml before use.

Procedure

1. Cover the MEA surface with 300 µl fibronectin solution and incubate the MEA at 37 °C for at least 1 h.
2. Aspirate the solution and rinse the MEA 2 x with PBS (phosphate buffered saline).
3. Plate the cells onto the MEA immediately after coating.

Literature

Ulrich Egert, Thomas Meyer (2004); Heart on a Chip — Extracellular multielectrode recordings from cardiac myocytes *in vitro*, "Methods in Cardiovascular Research", S. Dhein and M. Delmar (eds.)

5.4.7 Coating with Collagen

Coating with collagen is useful for short-term cultures. It tends to detach from the surface if used for long-term cultures.

Materials

- DMEM Dulbecco's Modified Eagle Media (DMEM) / F12 (Gibco/Invitrogen, 21331-020)
- N Hydrochloric acid, pH 3.0
- Acid-soluble type I collagen solution (3 mg/ml, pH 3.0) Cellmatrix Type I-A (Nitta Gelatin Inc.)

Preparation buffer

→ 200 mM HEPES in 0.08 N NaOH

Collagen solution

→ Add 1 ml of 10 x DMEM/F-12 medium to 8 ml Cellmatrix Type I-A and stir gently.

→ Add 1 ml of preparation buffer and stir gently.

→ Incubate the mixture at 4 °C for 30 min to remove any air bubbles, if necessary.

→ Store at 4 °C until use.

Procedure

1. Sterilize the MEA before the coating with collagen and perform all following steps under sterile conditions.
2. Incubate the MEA at 4 °C for at least 1h.
3. Fill the MEA with collagen solution until the bottom of the culture chamber is completely covered. Immediately remove the collagen solution with a glass pipette. The solution can be reused.
4. Incubate the MEA in a CO_2 incubator for 30 min. Rinse the MEA with sterile distilled water. Fill the MEA with culture medium and keep it sterile in a CO_2 incubator until use (for up to one week). Check for contaminations before use.

5.5 Cleaning of used MEAs

5.5.1 General Recommendations for Cleaning MEAs

The cleaning procedure depends on the kind of coating and on the kind of biological preparation. In the following, a few general considerations are listed.

- If you have recorded from an acute slice without coating, you can simply rinse the MEA with distilled water and the MEA should be fine.
- If necessary, the MEA can then be cleaned with any cleaning agent, for example, a standard dish-washing detergent. When cleaning coated MEAs, parts of the coating may go off. You have to recoat a MEA when the coating is not sufficient anymore, that is, when you observe problems with cell attachment or recording.
- If more severe methods are needed, the MEA can also be cleaned in an ultrasonic bath for a short moment. But this method is a bit dangerous, because there are ultrasonic baths that are too strong and will destroy the MEA. The behavior should be tested with an older MEA first. Generally is using an ultrasonic bath not recommended.
- EcoMEAs are easier to clean, because the golden electrodes are not so easily damaged.

5.5.2 Cleaning of pMEAs

Perforated MEAs have a robust ceramic or glass carrier, but the electrodes are embedded in polyimide foil. Therefore, they are heat stable to 50 °C only and cannot be autoclaved.

Please do not use ultrasonic bath for pMEAs!

→ Rinse with distilled water first, then apply 1% Terg-A-Zyme solution (Sigma) for several hours. Rinse the pMEA again with distilled water and dry them directly before use. Sterilization via rinsing with 70 % ethanol is possible. Do not immerse the pMEA into the alcohol for a longer time otherwise the ring may probably get off!

5.5.3 Cleaning of EcoMEAs

The gold electrodes of EcoMEAs are very robust and are the only MEA electrodes that will endure more severe cleaning methods. You can check the need for cleaning under a stereo microscope: The electrodes should be shiny and look golden. If they are gray, or if they show a film, you should clean them.

→ Carefully clean the electrodes with a swab and distilled water under microscopic control.

5.5.4 Cleaning of EcoFlexMEAs

EcoFlexMEAs made of polyimide (Kapton) have a temperature range from 0 – 125 °C. They can be sterilized by autoclavation.

→ If necessary, carefully clean the electrodes with a swab and distilled water under microscopic control.

5.5.5 Cleaning of FlexMEAs

FlexMEAs made of polyimide foil have a temperature range from 10 – 125 °C. They can be sterilized by autoclavation.

Please do not use an ultrasonic bath for FlexMEAs!

→ Rinse with distilled water first, optional with ethanol 70%.

5.5.6 Removing Nitrocellulose Coating

Note: It is very important that you clean MEAs that have been coated with nitrocellulose and remove all biological material first before removing the coating. If you applied methanol on an uncleaned MEA, you would rather fix the cell debris on the MEA than actually remove the coating.

1. Directly after usage, biological material is rinsed off under running water and the MEA is cleaned with pH-neutral cleaning agents or enzymatically if necessary.
2. Rinse the MEA 2 x with methanol. If nitrocellulose is not sufficiently removed by rinsing, incubate the MEA filled with methanol for 15 to 30 min to dissolve the cellulose nitrate.
3. Rinse the MEA with distilled water.

5.5.7 MEA Cleaning with EDTA-Collagenase

Materials:

- Collagenase Type I (Sigma-Aldrich, Inc., C0130)
- 0.5 mM EDTA
- Phosphate buffered saline (PBS) (Gibco/Invitrogen, 14190-144)

Collagenase solution:

→ Dissolve collagenase type I in PBS at 20 U/ml.

Method:

1. Fill the MEA culture chamber with 0.5 mM EDTA and incubate for 30 min.
2. Rinse the chamber 3 times with PBS.
3. Fill the MEA with collagenase solution and incubate for at least 30 min at 37 °C.
4. Discard the collagenase solution and rinse the MEA with distilled water at least 3 times.
5. Air dry the MEA, preferably under a laminar flow hood.

5.5.8 MEA Cleaning with Terg-A-Zyme

Materials:

- Terg-A-Zyme (Sigma-Aldrich, Inc., Z273287)
- Distilled water

Terg-A-Zyme solution:

→ Prepare a 1 % solution of Terg-A-Zyme in distilled water.

Method:

1. Place the MEA in 1 % Terg-A-Zyme solution overnight at room temperature.
2. Apply gentle shaking or rocking, if possible.
3. After Terg-a-Zyme treatment, rinse the MEA thoroughly with distilled water. (Terg-A-Zyme solution can be stored at 4 °C and reused for about a week).
4. Dry the MEA and apply hydrophilic surface treatment, if necessary (Please see above).
5. If the MEA is going to be used for cell or tissue culture, autoclave the MEA at 121 °C for 30 min.
6. Do not fix cells or tissues on a MEA. Detergent treatment will not remove fixed tissues.

Important: **NEVER** wipe the electrode field or touch it otherwise!

Warning: It is absolutely necessary to rinse the MEAs thoroughly with distilled water after treatment with detergent, particularly when using Terg-A-Zyme before heat sterilization (dry-heat sterilization is not recommended). Otherwise the potential rests of the detergent may burn into the glass carrier of the MEA and may destroy the electrodes.

6 Culture Chamber and Ring Options

You have several options regarding culture chamber interface rings (without ring, glass ring, plastic ring without and with thread) and culture chambers, which are especially useful for long-term cultures or experiments. For more details or pricing information, please ask your local retailer.

6.1 MEA2100-CO2-C

The MEA2100-CO2-C is a climate chamber for MEA2100-Systems. Connect the chamber via magnetic forces on the lid of a MEA2100 headstage to create a 5 % CO_2 atmosphere (humid or non humid) around the biological probe. Connect a tube with an inner diameter of +/- 2.3 mm to the tube connector.

6.2 Sealed MEA Culture Dish

In order to allow long-term cultivation and recording, Multi Channel Systems recommends the use of teflon membranes (fluorinated ethylene-propylene, 12.5 microns thick) developed by Potter and DeMarse (2001). The ALA-MEA-MEM membrane is produced in license by ALA Scientific Instruments Inc., and distributed via the worldwide network of MCS distributors.

The sealed MEA culture chamber with transparent semipermeable membrane is suitable for all MEAs with glass ring. A hydrophobic semipermeable membrane from Dupont that is selectively permeable to gases (O_2, CO_2), but not to fluid and H_2O vapor, keeps your culture clean and sterile, preventing contaminations by airborne pathogens. It also greatly reduces evaporation and thus prevents a dry-out of the culture.

Reference

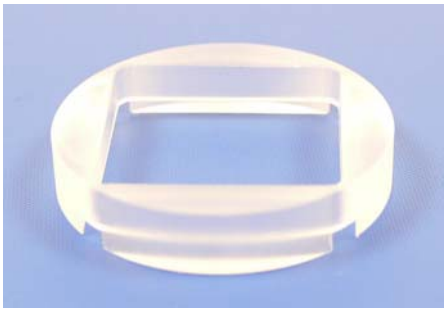
- Reference: Potter, S. M. and DeMarse, T. B. (2001). "A new approach to neural cell culture for long-term studies." J Neurosci Methods 110(1-2): 17-24.

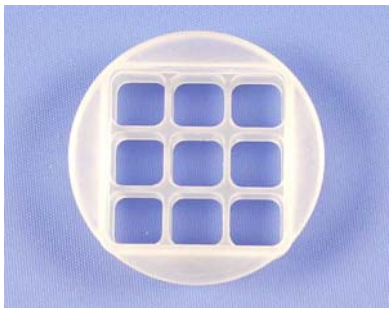
6.3 MEA Culture Chamber with Lid

Another possibility is to use a MEA culture chamber with lid (available from Multi Channel Systems), which is suitable for all MEAs with plastic ring and thread. It can be adapted by inserting metal perfusion cannulas for setting up a continuous perfusion.

6.4 Culture Chamber for 9-Well MEAs

The culture chamber ring 9well-CC for 256-9wellMEAs is suitable for the 9well macrolon quadrat (available from Multi Channel Systems). To use the macrolon quadrat in combination with the 9well-CC as a culture chamber, please insert a foil between macrolon quadrat and 9well-CC ring.

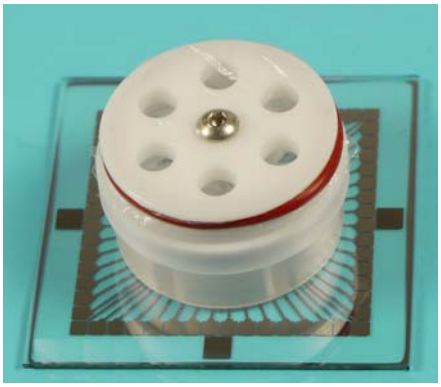




9well-CC for 256-9wellMEA300/30iR-ITO

6.5 Culture Chamber for 6-Well MEAs

The 6well-CC culture chamber is suitable for 6well macrolon rings on 60-6wellMEAs (available from Multi Channel Systems). The removable membrane cover for 60-6wellMEAs is available for triangle and round chamber rings.



6well-CC

6.6 Ring Options

The following table shows all available ring options. Glass rings (-gr) are available in two heights of 6 or 12 mm. Plastic rings (-pr) are available in four heights and without or with thread (-pr-T).

The triangle(-tcr) and round (-rcr) chamber rings are suitable for the 6 well MEAs, the macrolon quadrates (-mq) for the 252-9wellMEAs.

MEA Ring Options

multichannel systems

	Glass rings (-gr)	Plastic rings (-pr)	Plastic rings with thread (-pr-T)	6-well rings	9-well rings
Culture chambers/ lids to be placed on rings	ALA MEA-MEM ID: 24.5 mm, OD: 31 mm		Culture chamber lid (CCL) Culture chamber (CC)	Culture chamber (6well-CC) + ALA MEA-MEM-SHEET	Culture chamber (9well-CC) + ALA MEA-MEM-SHEET
	ALA MEA-INSERT		Culture chamber interface ring (CCIR)	Set of 5 culture chambers (6well-CC-Set)	
	ALA MEA-MEM-PL				
Rings (standard)	Glass ring (-gr) 6 mm high ID: 19 mm, OD: 24 mm	Plastic ring (-pr) 6 mm high ID: 26.5 mm, OD: 30 mm	Plastic ring with thread (-pr-T) 6 mm high ID: 26 mm, OD: 30 mm	Triangle chamber ring (-tcr), 10 mm high OD: 30 mm	Plastic quadrade (-mq), 9 mm high OD: 24 mm
				Round chamber ring (-rcr), 10 mm high OD: 30 mm	
Rings (optional, on request)	Glass ring 12 mm high ID: 19 mm, OD: 24 mm	Plastic ring 3 mm high ID: 26.5 mm, OD: 30 mm	Plastic ring with thread 15 mm high ID: 26 mm, OD: 30 mm		

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Product information is subject to change without notice.

Please note: Not all rings can be placed on all MEAs. Please check exact order description.

7 Recording with MEAs

7.1 Mounting the MEA

7.1.1 Cleaning the Contact Pads

You should always clean the contact pads with alcohol before placing it into the MEA amplifier. Even if you do not see any contaminations, a very thin grease layer from touching the pads with bare fingers, for example may be present and results in a bad contact between the pads and the amplifier pins. A bad contact will result in an increased noise level on the affected channel. This is the most prominent handling error.

→ Carefully wipe the MEA contact pads with a clean and soft tissue moistened with pure alcohol.

7.1.2 Positioning the MEA

Important: MEAs are not symmetrical! That is, why the **writing** (for example NMI, LEITER, MEA type) on the MEA chip should be on the right side viewed from the front, with the sockets of the amplifier in the back. MEAs with one big internal reference electrode should be placed with reference electrode to the left side in the amplifier. Otherwise, the MEA layout will not match with the pin layout of the channel map in the data acquisition program.

When placing a special MEA into the amplifier, for example 120MEA, HighDense MEA, 4Q1000 MEA or HexaMEA, please make sure that the orientation of the MEA is correct, respectively.

7.1.3 Grounding the Bath

Make sure that the bath is connected to the amplifier's ground.

→ Attach the provided silver wire or Ag/AgCl pellet to the amplifier's ground and place it into the bath.

→ — OR — If you use a MEA with internal reference electrode, connect the ground to the reference electrode socket (pin 15) with the provided connector.

Please see the manual of the respective MEA amplifier for more information about mounting MEAs and grounding.

7.2 General Performance / Noise Level

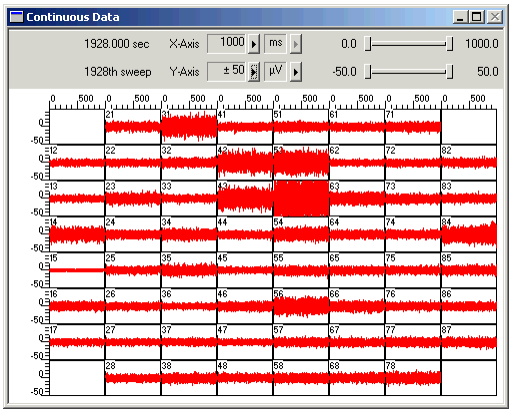
You can test a MEA before use by filling it with a standard saline buffer, for example PBS (phosphate buffered saline), and recording the noise level of the MEA and the amplifier.

MEA amplifiers have a maximum noise level of +/– 8 µV. The noise level on the MEA depends on the electrode size and material. The smaller the electrode, the higher is the noise level. TiN electrodes have a larger surface area due to their microfold structures, and therefore they have generally a lower impedance and a lower noise level than electrodes of the same size that are made from other materials (for example, Pt electrodes).

The total maximum noise level for a MEA and the amplifier should be about +/– 40 µV peak to peak for 10 µm TiN electrodes and +/– 10 µV for 30 µm TiN electrodes.

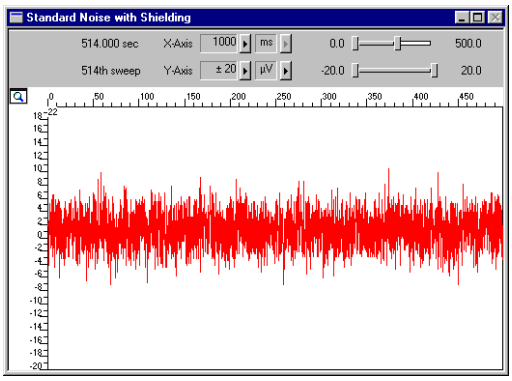
The initial noise level may be higher if the MEAs are hydrophobic. New MEAs should be made hydrophilic before use.

Typical noise level of a used standard 60MEA200/30iR-Ti (round 30 µm Tin electrodes)

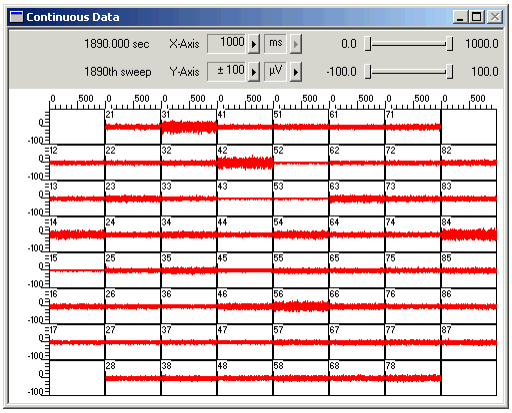


This picture shows the typical noise level of a standard 60MEA200/30iR-Ti on most electrodes, recorded with a MEA1060-BC amplifier.

Electrodes 43, 52, 53, and 84 show an increased noise level after a longer cycle of use. The bath was grounded with the internal reference electrode 15. Time axis: 1000 ms, voltage axis: ±50 µV. You should ground some of the electrodes if you want to use this MEA for recording.

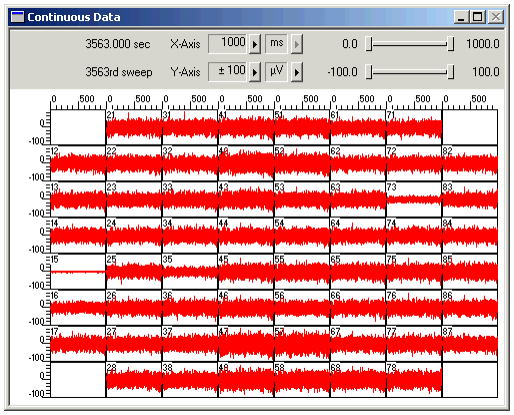


Same MEA, zoom to single channel # 22. Time axis: 500 ms, voltage axis: ±20 µV.



Same MEA after grounding defective electrodes. Time axis: 1000 ms, voltage axis: ±100 µV.

Typical noise level of a standard 60MEA200/10iR-Ti (round 10 µm Tin electrodes)



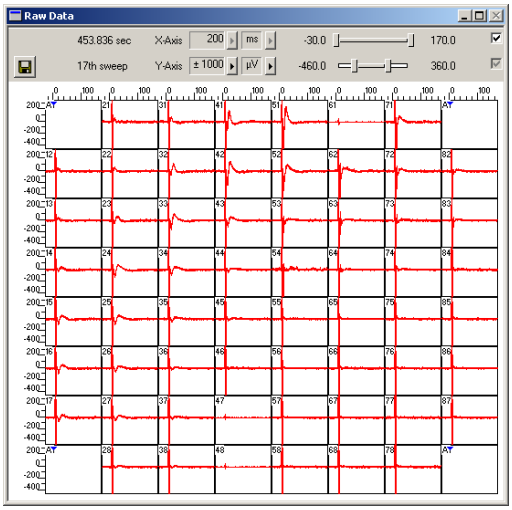
Noise level of a new standard 60MEA200/10iR-Ti. Bath grounded with the internal reference electrode 15. Time axis: 1000 ms, voltage axis: ±100 µV.

8 Stimulation

8.1 Using MEA Electrodes for Stimulation

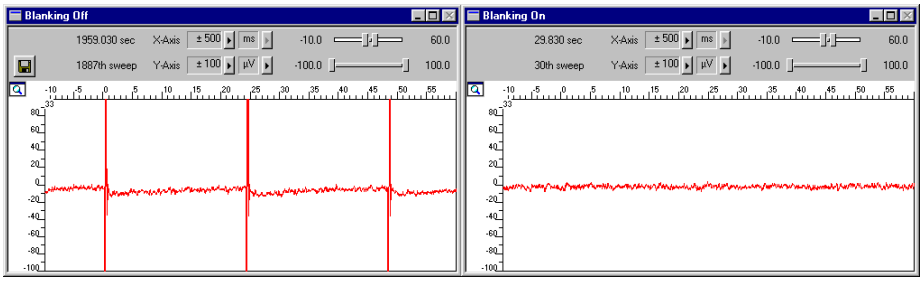
You can use **any MEA electrode(s)** for stimulation. Simply connect the stimulus generator outputs to the MEA amplifier. Please see the manual for the respective MEA amplifier and stimulus generator for more details. As an alternative, you can also use special 60StimMEA with four pairs of large (250 x 50 µm) stimulating electrodes and a special stimulation adapter, or target cells with an external electrode for stimulation. This and the following chapters are intended for helping you to optimize the stimulation with MEA electrodes.

All electrodes suffer under electrical stimulation, especially under long-term stimulation. The wear depends on the stimulus and on the electrode type. When stimulating via MEA electrodes and with standard MEA amplifiers, you will see a stimulus artifact on all amplifier channels during stimulation due to the high charge that is injected into the circuit, and the following saturation of the filter amplifiers. The time constant of the stimulus artifact depends on the amplifier bandwidth; if the lower cutoff frequency is quite low, for example, 1 Hz, the stimulus artifact will be longer than with 10 Hz, for example. In most cases, it will not be possible to record true signals that are close to the stimulus pulse. This can be avoided by using a MEA amplifier with blanking circuit. The stimulating electrode can generally not be used for recording in parallel to stimulation, because the injected charge is so high, and the time constant for discharging so low.



The screen shot shows a prominent stimulus artifact on all channels, followed by a response.
The stimulating electrode No. 61 has been grounded.

The next pictures demonstrate the blanking feature. On the left screen shot, you see the stimulus artifacts on a non-stimulating electrode without blanking. On the right, you see the same electrode and stimulation pattern, but with blanking. The stimulus artifacts have been completely avoided, making it possible to detect signals shortly after the stimulus.



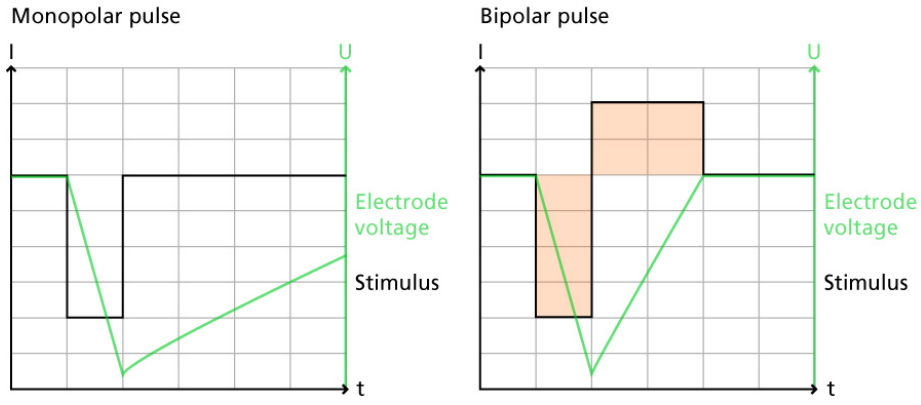
8.2 Capacitive Behavior of Stimulating Electrodes

Regarding the generally used stimulus pulses, stimulating electrodes behave as plate capacitors. The charge cannot flow back to the stimulus generator due to the high output resistance and thus is kept in the electrode. The electrode needs a quite long time to discharge itself after stimulation. As a result, stimulus artifacts interfere with the recording, and electrodes deteriorate over time due to electrolysis. You can avoid that by choosing an appropriate stimulus protocol that actively discharges the electrode after the pulse.

When using **voltage** driven stimulation, the electrodes are discharged when the voltage level is set to zero at the end of the (monophasic) pulse. Not so in **current** mode. When applying a negative current pulse, the electrode is charged and needs to be actively discharged by applying an inverted pulse with a matching product of current and time, that is, you need to stimulate with biphasic pulses for current driven stimulation to reduce both the stimulus artifact and to avoid an electrode damage. The easiest way is to use the same signal amplitude and the same duration with an inverse polarity. For voltage driven stimulation, monophasic pulses are fine.

The following illustration shows the effect of a biphasic current pulse on the discharge of the stimulating electrode. As you can see, the first monophasic pulse is followed immediately by a pulse of the opposite polarity and the same product of current and time.

Effect of a bipolar pulse on the electrode voltage



8.3 Aspects of Electrode Size and Material

Titanium nitrite (TiN) electrodes are generally more robust than electrodes from other materials, for example platinum (Pt). In the Appendix, you find safe charge injection limit curves that document maximum current and stimulus durations for standard TiN electrodes. Please note that these curves document the limits. Stimulus pulses should be kept safely below these limits. The safe charge injection limit of platinum (0.4 mC/cm^2) is much smaller than for TiN (23 mC/cm^2). This fact results in a considerably lower charge that you can inject into the electrode before faradic reactions occur that will lead to electrolysis of the electrode.

Please note that, when using voltage driven stimulation, the current flow to the electrode depends on the electrode impedance. The **lower** the **impedance**, the **higher** is the **current**. Please make sure to obey the safe charge injection limits always. Generally, TiN electrodes have lower impedances than Pt electrodes, and larger electrodes also have lower impedances than smaller.

When using TiN electrodes, it is extremely important to not charge the electrodes positively, as this will lead to electrolysis. (This is not an issue for Pt electrodes.) Therefore, when using voltage driven stimulation, it is important to apply negative voltages only. Positive voltages will shortly charge the electrodes positively, even though the electrode is discharged at the end of the pulse. As a consequence, biphasic voltage driven stimulation is not recommended. When using current stimulation, it is required to use biphasic stimulation, and to apply the negative phase first, to avoid a positive net charge on the electrode.

8.4 Recommended Stimulus Amplitudes and Durations

The higher the amplitude and the longer the stimulus, the higher is the impact on the electrode performance. Therefore, the amplitude and duration should be **as low as possible**. It is advisable to start with a low amplitude and duration, and then increase it slowly until responses are evoked.

The allowed product of amplitude and duration is directly proportional to the electrode surface. The higher the amplitude, the shorter is the maximum duration of the pulse, and vice versa. Do not apply pulses with a higher amplitude or for a longer time than is recommended for the electrode type. TiN electrodes have a rough surface structure and therefore have a larger surface than electrodes of the same size but made of a different material. The **safe-charge injection limits** in the appendix describe the relationship between maximum pulse amplitude and time for TiN electrodes.

As a consequence of the points discussed above, Multi Channel Systems recommends using **negative monophasic voltage** pulses to make sure that the voltage level of the stimulating electrode is zero, and thus the electrode is discharged, at the end of the pulse.

According to the experience of MEA users, voltage pulses should be < 1 V (–100 mV to –900 mV) for neuronal applications to avoid damage to electrode and cells. Generally, pulse durations between 100 to 500 µs are used. (See also Potter, S. M., Wagenaar, D. A. and DeMarse, T. B. (2005). "Closing the Loop: Stimulation Feedback Systems for Embodied MEA Cultures." Advances in Network Electrophysiology Using Multi-Electrode Arrays. M. Taketani and M. Baudry, Springer; Wagenaar, D. A., Madhavan, R., Pine, J. and Potter, S. M. (2005). "Controlling bursting in cortical cultures with closed-loop multi-electrode stimulation." J Neurosci 25(3): 680-8.)

For pacing cardiomyocytes, higher voltages and durations are generally required, for example, –2 V for 2 ms. As these pulses are not supported by standard MEA electrodes, the use of larger stimulating electrodes is recommended. A special MEA with four pairs of large (250 x 50 µm) stimulating electrodes (60StimMEA200/30) and a special stimulation adapter is provided for such applications by Multi Channel Systems.

Warning: When using MEA electrodes of TiN material, use only negative voltages pulses or biphasic current pulses applying the negative phase first. Always regard the **safe-charge injection limits** as described in the appendix of this manual. Otherwise, electrodes can be irreversibly damaged by electrolysis.

9 Troubleshooting

9.1 About Troubleshooting

The following hints are provided to solve special problems that have been reported by users. Most problems occur seldom and only under specific circumstances. Please check the mentioned possible causes carefully when you have any trouble with the product. In most cases, it is only a minor problem that can be easily avoided or solved.

If the problem persists, please contact your local retailer. The highly qualified staff will be glad to help you. Please inform your local retailer as well if other problems that are not mentioned in this documentation occur, even if you have solved the problem on your own. This helps other users, and it helps Multi Channel Systems to optimize the instrument and the documentation.

Please pay attention to the safety and service information (chapter "Important Information and Instructions"). Multi Channel Systems has put all effort into making the product fully stable and reliable, but like all high-performance products, it has to be handled with care.

9.2 Technical Support

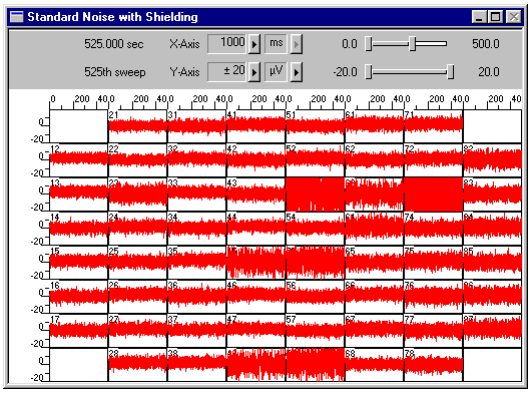
Please read the Troubleshooting part of the user manual first. Most problems are caused by minor handling errors. Contact your local retailer immediately if the cause of trouble remains unclear. Please understand that information on your hardware and software configuration is necessary to analyze and finally solve the problem you encounter.

Please keep information on the following at hand

- Description of the error (the error message text or any other useful information) and of the context in which the error occurred. Try to remember all steps you had performed immediately before the error occurred. The more information on the actual situation you can provide, the easier it is to track the problem.
- The serial number of the MEA. You will find it on the MEA case.
- The amplifier type and serial number. You will find it on the device.
- The operating system and service pack number on the connected computer.
- The hardware configuration (microprocessor, frequency, main memory, hard disk) of the connected computer. This information is especially important if you have modified the computer or installed new hard- or software recently.
- The version of the recording software. On the "Help" menu, click "About" to display the software version.

9.3 Noise on Single Electrodes

The noise level on single electrodes is significantly higher than expected or you see artifact signals. In the following example (60MEA200/30, filled with PBS (phosphate buffered saline), silver pellet as bath electrode, shielded), electrodes No. 53, 63, 73, 45, 55, 48, 58 show a high noise level.

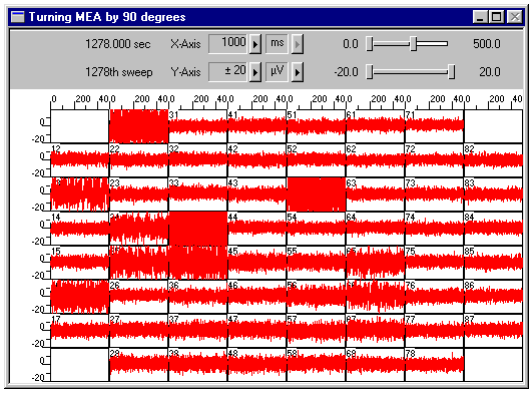


Possible causes:

? The electrode or the contact pin of the amplifier may be defective. To test this, do the following.

1. Open the amplifier and turn the MEA by 90 degrees.
2. Close the amplifier again and start the recording.

If the same electrode in the MEA layout is affected, the amplifier's contact is not ok. If another electrode is now affected and the previously affected electrode is ok now, the MEA electrode is not ok, but the amplifier is fine. The following screen shot shows the same MEA than above that has been turned clockwise by 90 degrees. You see that different channels are now affected, which indicates that the amplifier is fine but some electrodes on the MEA are defective.



— OR —

→ Use the test model probe to test the amplifier. If the noise level is fine without the MEA, bad MEA electrodes cannot be the cause.

MEA is defective

MEAs wear out after multiple uses or over a longer time of use, for example for long-term cultures. This is considered a normal behavior. MEAs are also easily damaged by mishandling, for example if wrong cleaning solutions or too severe cleaning methods are used or if the recording area is touched. If you observe a bad long-term performance of MEAs, consider a more careful handling.

Possible causes:

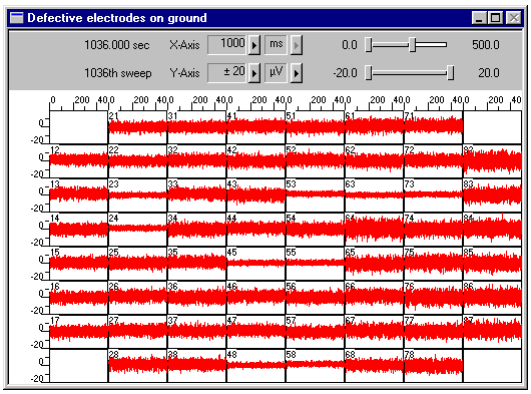
? The contact pads are contaminated.

→ Clean the contact pads carefully with a swab or a soft tissue and pure (100 %) alcohol.

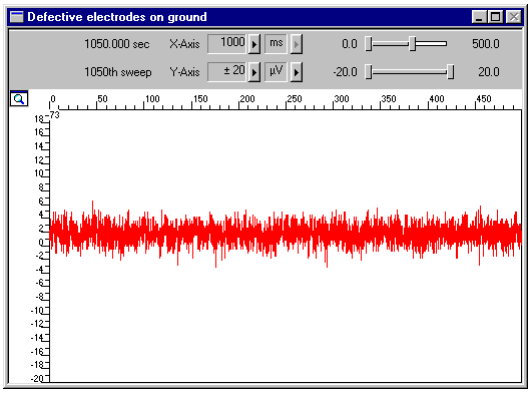
? The contact pads or the electrodes are irreversibly damaged. You could have a look at the electrodes under a microscope: If they appear shiny golden, the titanium nitride is gone and the electrode is irreversibly damaged. Electrodes may be damaged without changing their visual appearance, though.

→ Pick one of the bad channels after the other and ground it. See the MEA amplifier's manual for more information on grounding channels. In most cases, only one of the electrodes that appear bad is actually defective, and the other ones are only affected by the single defective electrode. Ground as many electrodes as you need for a good general performance.

In the following example, all defective electrodes have been grounded.



Grounded electrodes show a noise level that is lower than that of good electrodes.



→ If too many electrodes are defective, use a new MEA.

Contact pin is defective

Please see the manual for the respective MEA amplifier.

9.4 Overall Noise / Unsteady Baseline

The baseline is unstable, signals are jumping or drifting.

Possible causes:

? Bath electrode is not connected to ground.

→ Connect the internal or external bath electrode to one of the ground inputs of the amplifier.

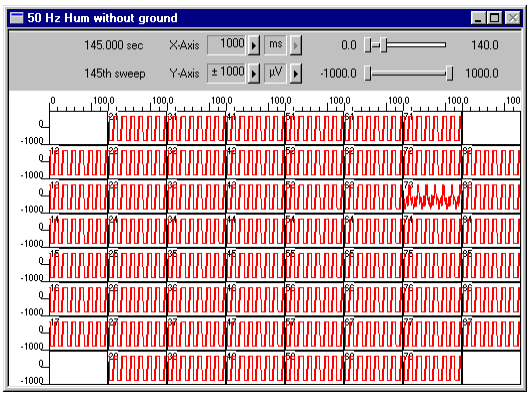
? AgCl bath electrode needs is not well-chlorided.

→ Rechloride the electrode or use a new one.

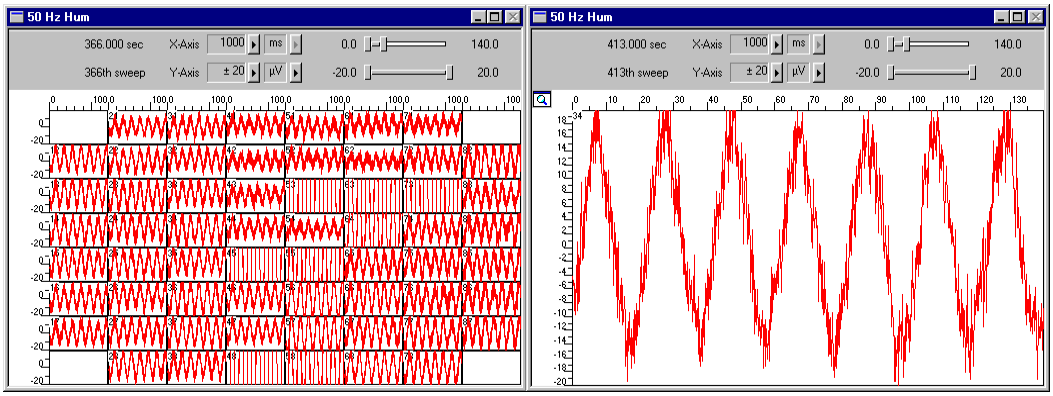
? 50 Hz hum: 50 Hz is the frequency of mains power in Europe. If the shielding and grounding of the setup is not sufficient, electrical signals are picked up from the environment.

→ Use a proper shielding. For example, you can place aluminum foil over the amplifier that is connected to any metal part of the MEA amplifier. You can also use special shielding equipment like a Faraday cage.

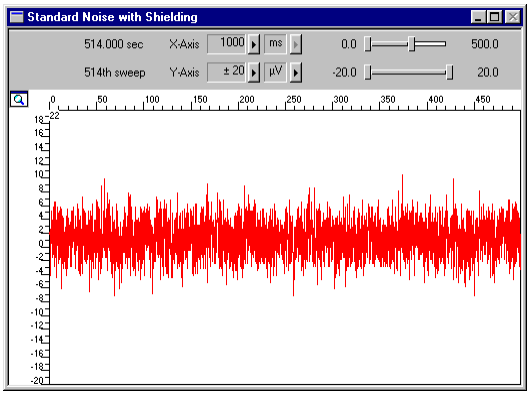
The following screen shot shows a recording of a 60MEA200/30 **without bath electrode** and **without shielding**. You see that the signals are so high that the amplifier gets saturated, and you see a very strong 50 Hz hum.



The next pictures show the same MEA **with bath electrode** (silver pellet), but **without shielding**. The baseline is very unsteady and oscillates with a frequency of 50 Hz.



The next screen shot shows the effect of **shielding**: The noise level is neglectible, and the baseline is steady. The shielding has been achieved with a metal plate connected to the metal part of the 68-pin MCS high grade cable connector and placed above the amplifier. You could also use aluminum foil or a Faraday cage for the same effect, for example.



9.5 Missing Spikes or Strange Signal Behavior

MEAs wear out after multiple uses or over a longer time of use, for example, for long-term cultures. The insulation layer gets thin over time. This is considered a normal behavior.

Possible causes:

? The insulation layer is too thin. As a result, the MEA gets the behavior of a low pass filter. This means, that the signal frequency may be shifted to a lower frequency, and spikes are missing.

→ Optically control the MEA with a microscope. If concentric colored rings (Newton rings) are visible (due to light interference), the insulation layer is too thin and you should use a fresh MEA.

? The insulation layer has been abraded and is missing in parts. This will result in a short circuit between the electrodes or tracks and the bath. You will still see signals, but as an unspecific smear over the complete array.

→ Use a fresh MEA.

10 Appendix

10.1 Contact Information

Local retailer

Please see the list of official MCS distributors on the MCS web site.

User forum

The **Multi Channel Systems User Forum** provides an excellent opportunity for you to exchange your experience or thoughts with other users worldwide.

Mailing List

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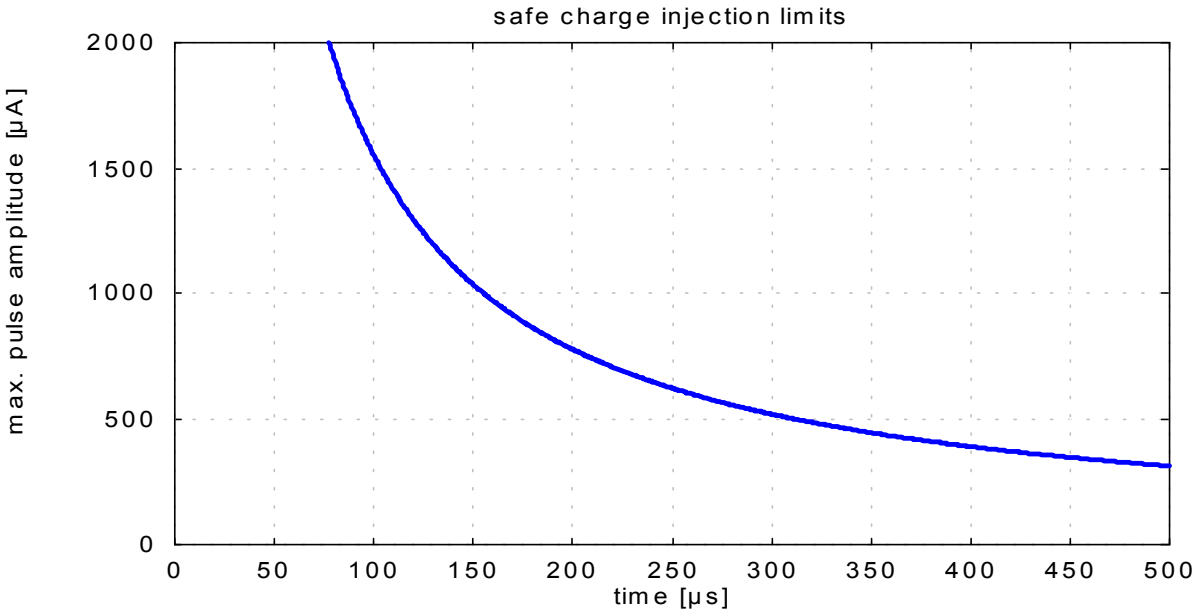
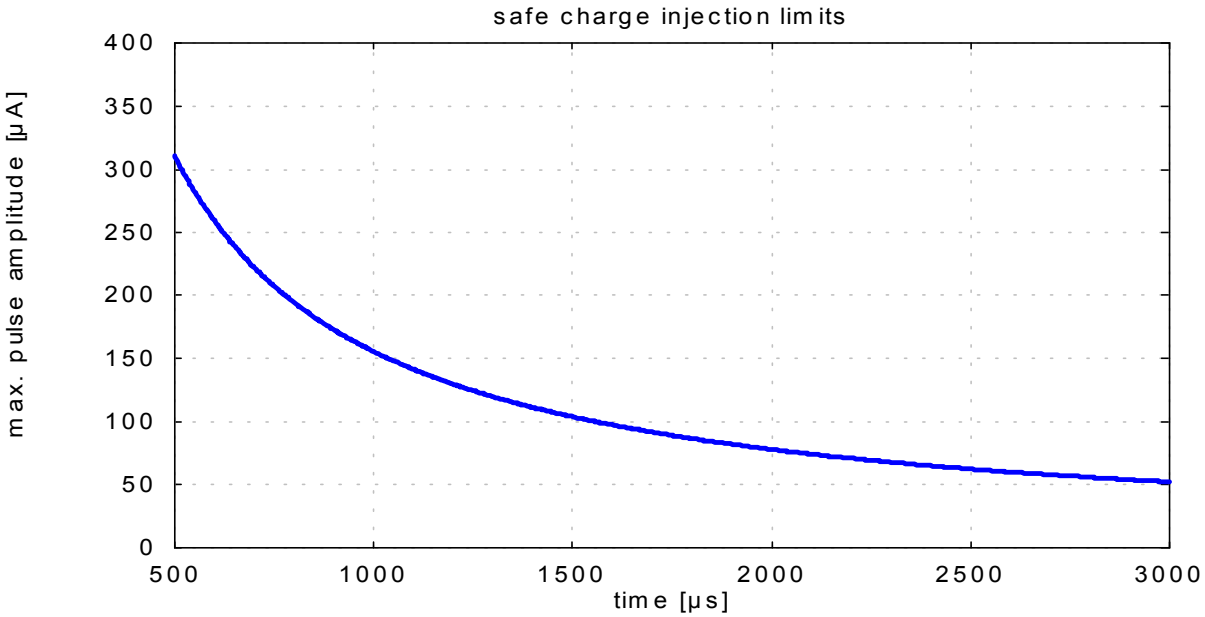
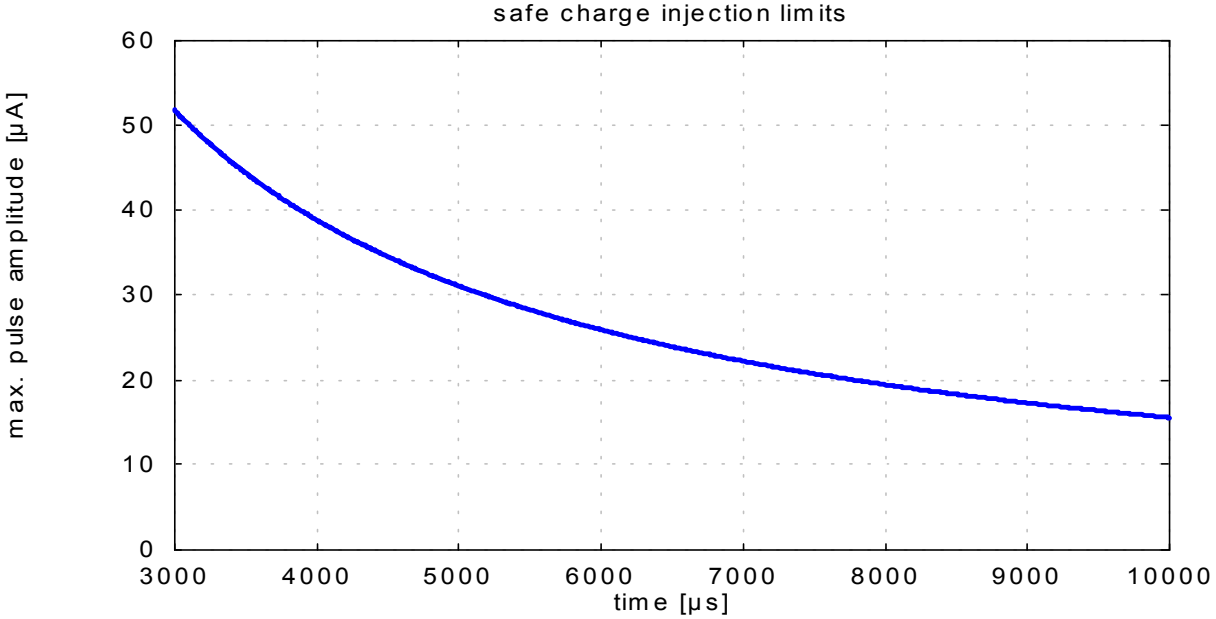
10.2 Safe Charge Injection Limits

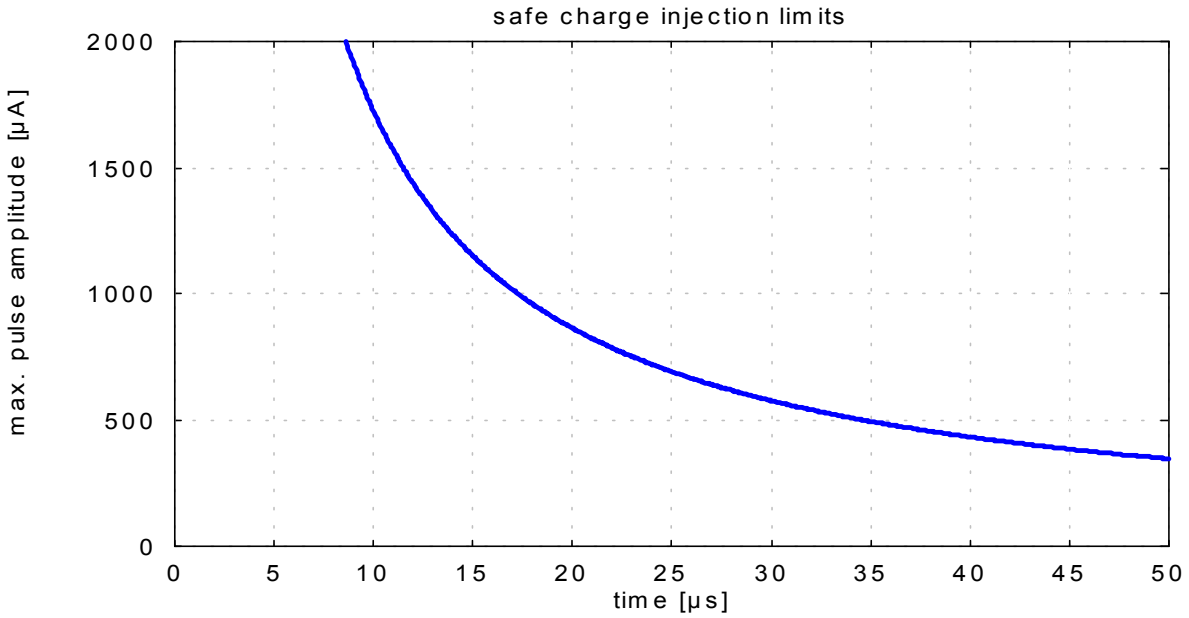
Safe Charge Injection Limits of Micro Electrode Arrays with TiN Electrodes (diameter: 30 µm)

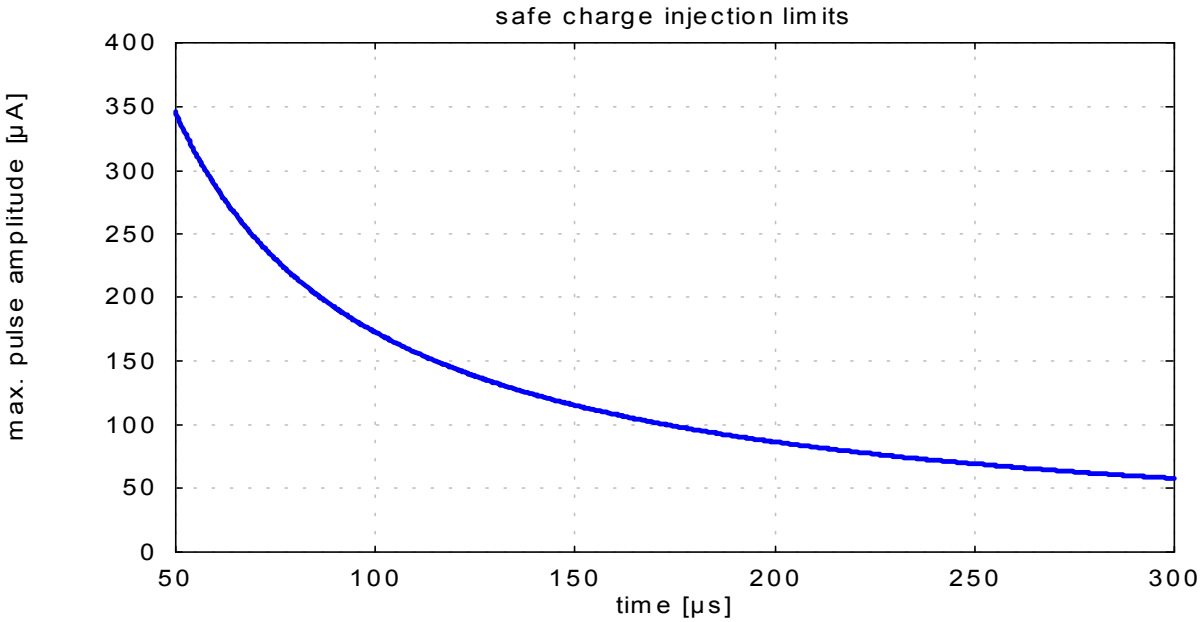


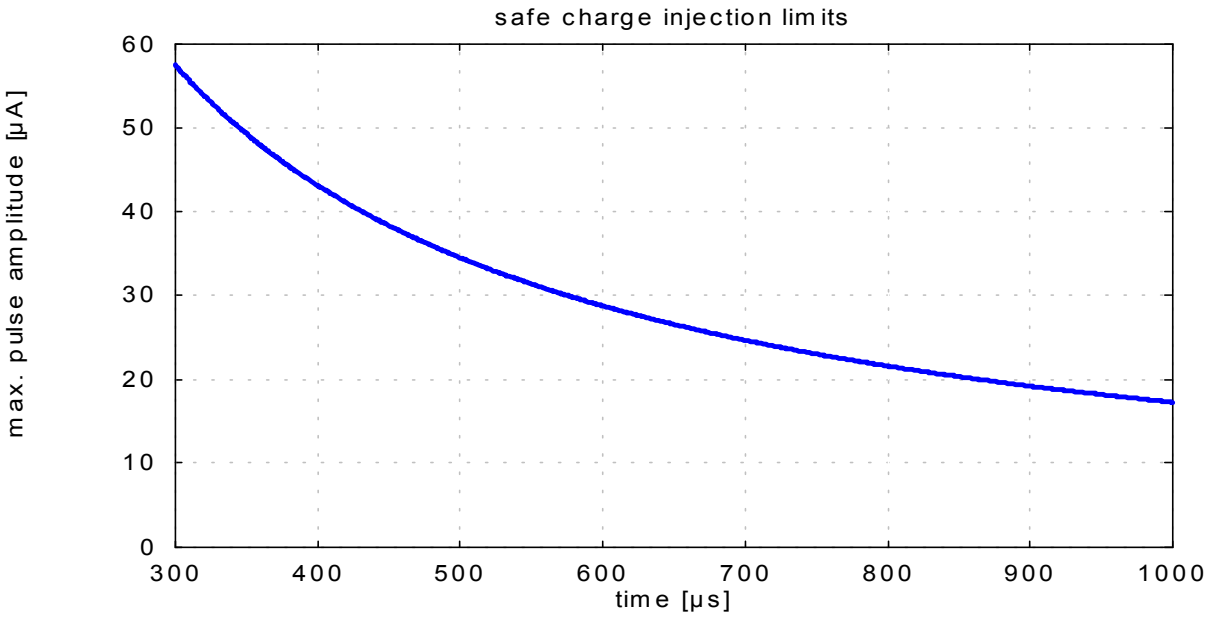




Safe Charge Injection Limits of Micro Electrode Arrays with TiN Electrodes (diameter: 10 µm)



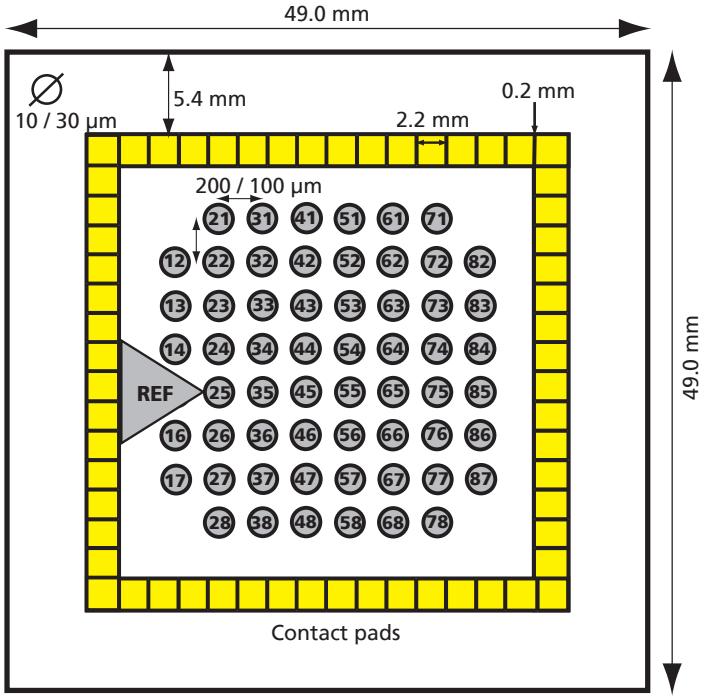


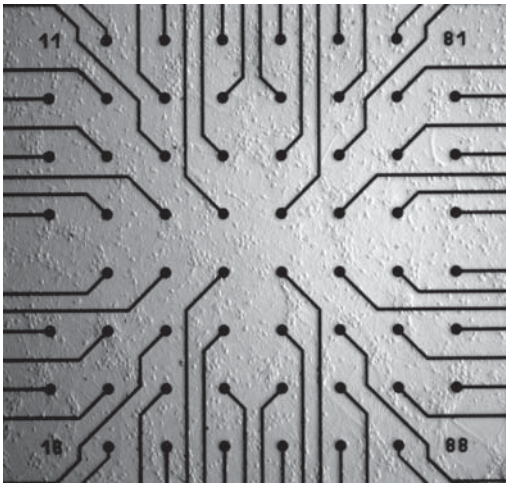


10.3 Data Sheets

Standard 60MEA

60MEA200/10iR-ITO, 60MEA200/30iR-ITO,
60MEA100/10iR-ITO, 60MEA100/10-ITO,
60MEA100/10iR-Ti, 60MEA200/30-Ti,
60MEA200/10iR-Ti, 60MEA200/30iR-Ti





Standard electrode layout grid 8 x 8

Technical Specifications Standard 60MEA

Temperature compatibility	0 - 125 °C
Dimension (W x D x H)	49 mm x 49 mm x 1 mm
Base material	Glass
Track material	ITO (Indium tin oxide) or Ti (Titanium)
Contact pads	ITO (Indium tin oxide) or TiN (Titanium nitride)
Electrode diameter	10 or 30 µm
Interelectrode distance (centre to centre)	100 or 200 µm
Electrode height	Planar
Electrode type	TiN (Titanium nitride)
Isolation type	Silicon nitride 500 nm (PEVCD)
Electrode impedance	30 - 50 kΩ for 30 µm electrodes, 250 - 400 kΩ for 10 µm electrodes
Electrode layout grid	8 x 8
Number of recording electrodes	59 (with iR) or 60 (without iR)
Number of reference electrodes	1 internal reference electrode (iR) or without internal reference
MC_Rack	
Source layout in "Data Source Setup"	2 dim. (MEA) or Configuration
Channel map	Default

MEA perfusion chamber	(w/o)	Without ring
	(gr)	Glass ring: ID +/- 19 mm, OD 24 mm, height 6 / 12 mm
	(pr)	Plastic ring without thread: ID 26.5 mm, OD 30 mm, height 6 / 3 mm
	(pr-T)	Plastic ring with thread: ID 26 mm, OD 30 mm, height 6 / 15 mm

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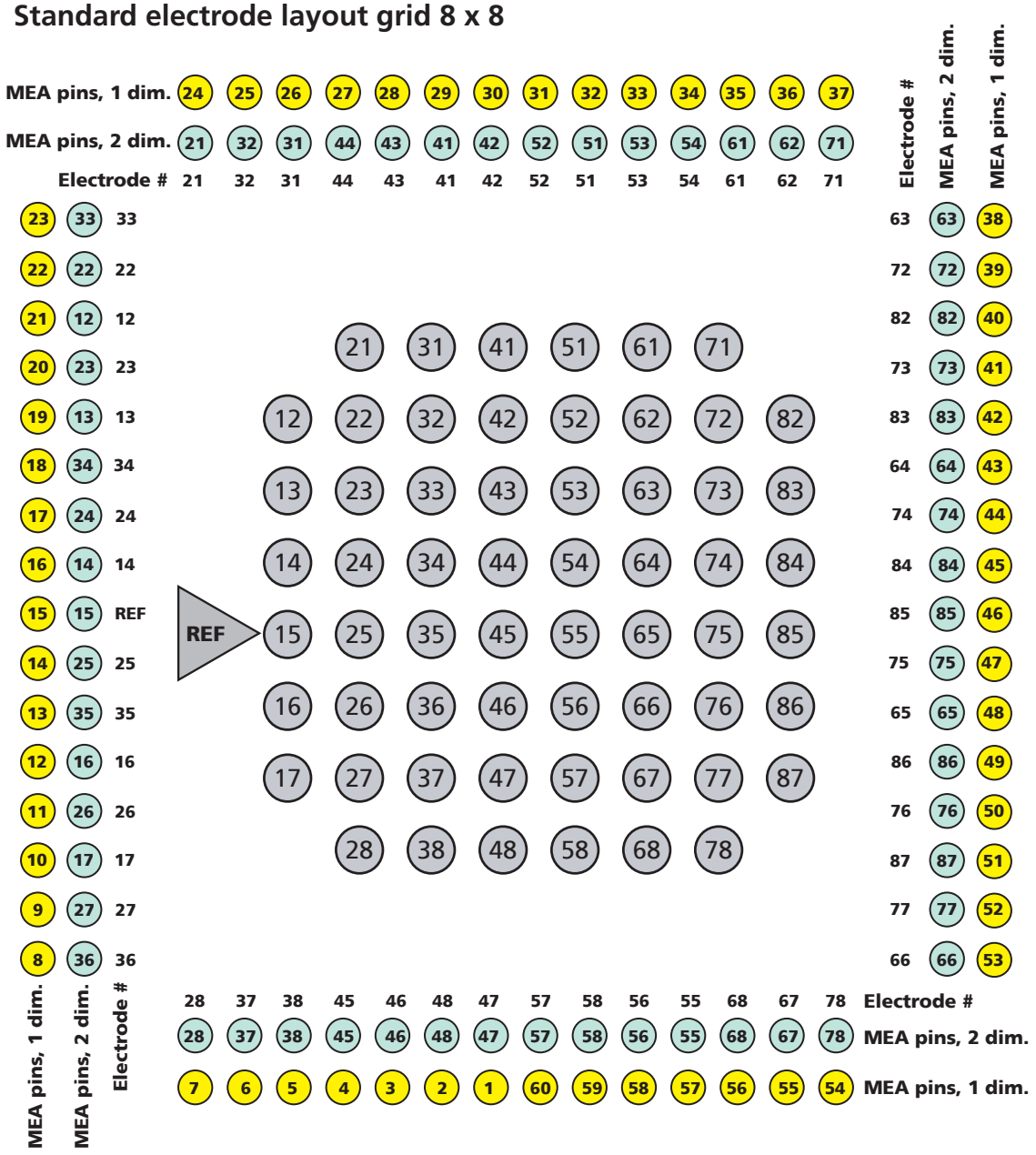
Standard 60MEA

Standard electrode layout grid 8 x 8



The numbering of MEA electrodes in the 8 x 8 grid follows the standard numbering scheme for square grids: The first digit is the column number, and the second digit is the row number. For example, electrode 23 is positioned in the third row of the second column.

The specified MEA pin numbers (1 dim. or 2 dim.) are the channel numbers that are used in the data acquisition program, when using the 1 dimensional layout or the 2 dimensional layout (or Configuration) in the "Data Source Setup". The electrode 15 is missing in MEAs with internal reference electrode. It is replaced by a big internal reference electrode, connected to pin 15 of the amplifier.

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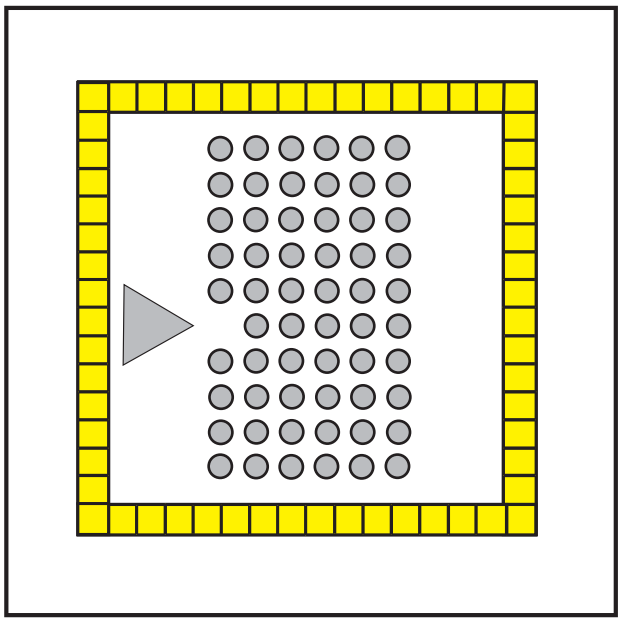
60MEA500/10iR-Ti

60MEA500/10iR-Ti, 60MEA500/30iR-Ti



MEA with electrode layout grid 6 x 10

Technical Specifications Micro Electrode Array with 6 x 10 Layout

Temperature compatibility	0 - 125 °C
Dimension (W x D x H)	49 mm x 49 mm x 1 mm
Base material	Glass
Track material	Ti (Titanium)
Contact pads	TiN (Titanium nitride)
Electrode diameter	10 or 30 µm
Interelectrode distance (centre to centre)	500 µm
Electrode height	Planar
Electrode type	TiN (Titanium nitride)
Isolation type	Silicon nitride 500 nm (PEVCD)
Electrode impedance	30 - 50 kΩ for 30 µm electrodes, 250 - 400 kΩ for 10 µm electrodes
Electrode layout grid	6 x 10
Number of recording electrodes	59
Number of reference electrodes	1 internal reference electrode (iR)
MC_Rack	
Source layout in “Data Source Setup”	2 dim. (MEA)
Channel map	MEA-500_6x10.cmp

MEA perfusion chamber	(w/o)	Without ring
	(gr)	Glass ring: ID +/- 19 mm, OD 24 mm, height 6 / 12 mm
	(pr)	Plastic ring without thread: ID 26.5 mm, OD 30 mm, height 6 / 3 mm
	(pr-T)	Plastic ring with thread: ID 26 mm, OD 30 mm, height 6 / 15 mm

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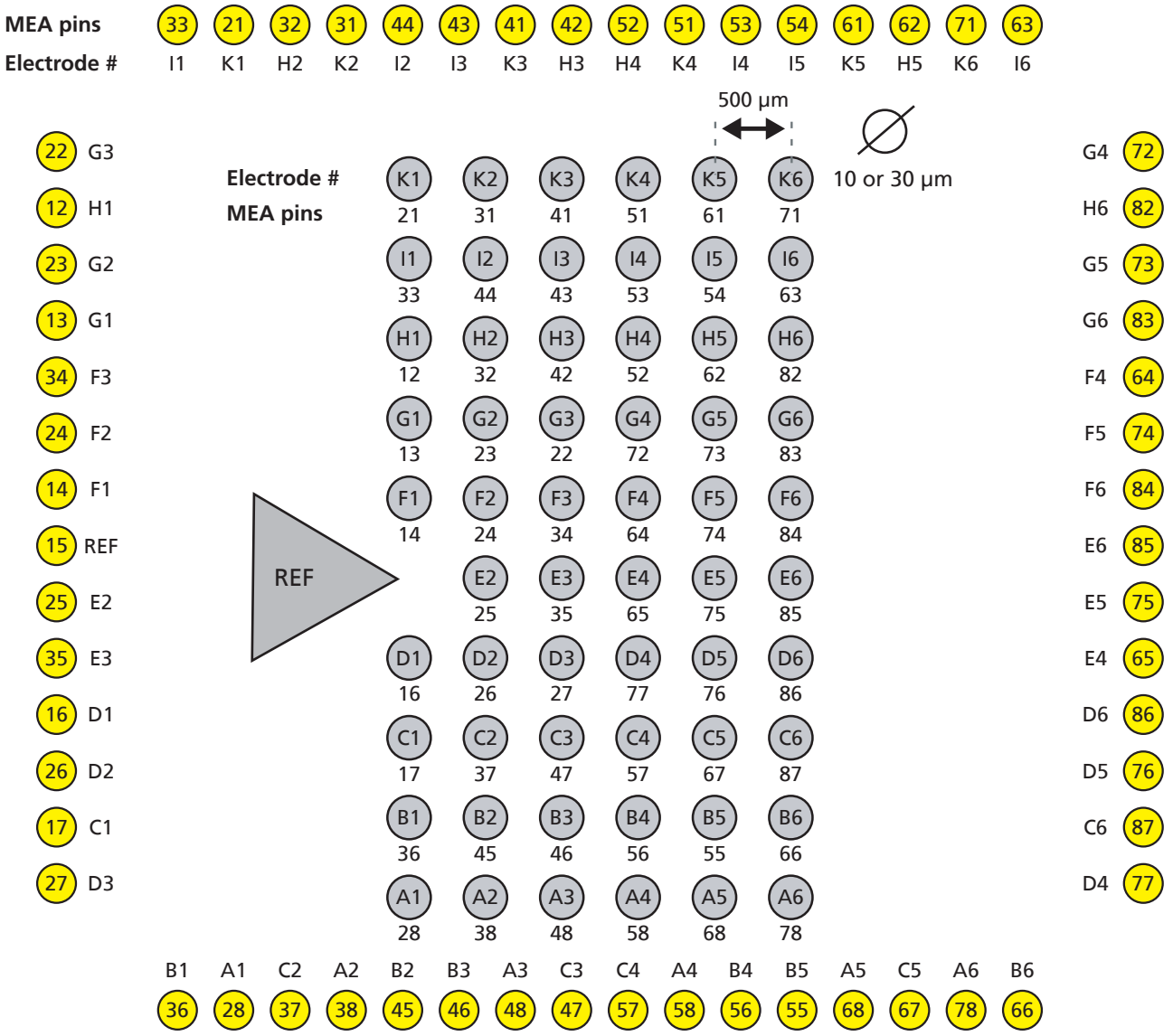
60MEA500/10iR-Ti

Electrode layout grid 6 x 10



The letter of the electrode number code refers to the row number, and the digit is the column number. The specified MEA amplifier pin numbers are the MEA-System channel numbers that are used in the MC_Rack program. The substrate-integrated reference electrode (REF) is connected to pin 15 of the MEA amplifier.

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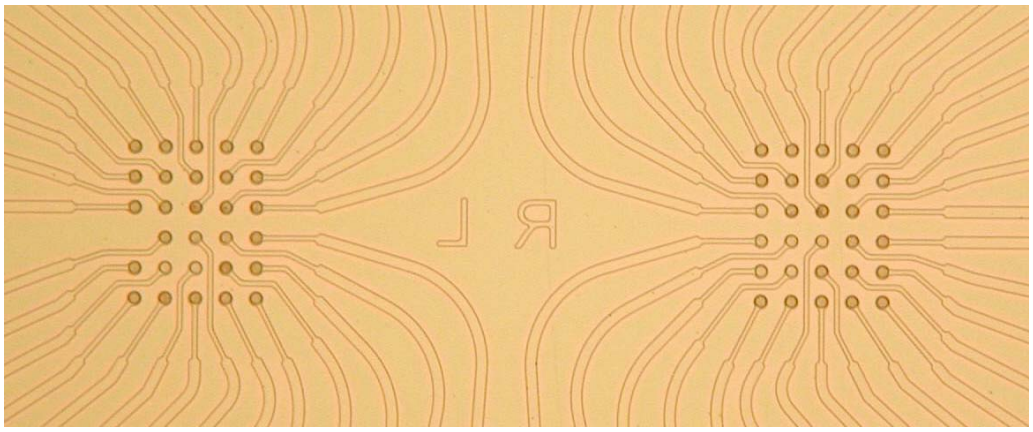
60HighDenseMEA

60HD30/10iR-ITO

60 High Density Microelectrode Array with Internal Reference Electrode



Technical Specifications: 60HighDenseMEA

Temperature compatibility	0 - 125 °C
Dimension (W x D x H)	49 mm x 49 mm x 1 mm
Base material	Glass
Contact pads and track material	Indium tin oxide (ITO)
Electrode diameter	10 µm
Interelectrode distance (centre to centre)	30 µm
Distance between electrode fields	500 µm or 150 µm
Electrode height	Planar
Electrode type	Titanium nitride (TiN)
Isolation type	Silicone nitride 500 nm (PEVCD)
Electrode impedance	Approximately 250 - 400 kΩ
Electrode layout grid	2 x (5 x 6)
Number of recording electrodes	59
Number of reference electrodes	1 internal reference electrode
MC_Rack:	
Source Layout in Data Source Setup	2 dim. (MEA)
MCS Channel map	HighDenseMEA.cmp HighDenseMEA_L.cmp HighDenseMEA_R.cmp

MEA perfusion chamber	(w/o)	Without ring
	(gr)	Glass ring: ID +/- 19 mm, OD 24 mm, height 6 / 12 mm
	(pr)	Plastic ring without thread: ID 26.5 mm, OD 30 mm, height 6 / 3 mm
	(pr-T)	Plastic ring with thread: ID 26 mm, OD 30 mm, height 6 / 15 mm

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60HighDenseMEA

60HD30/10iR-ITO

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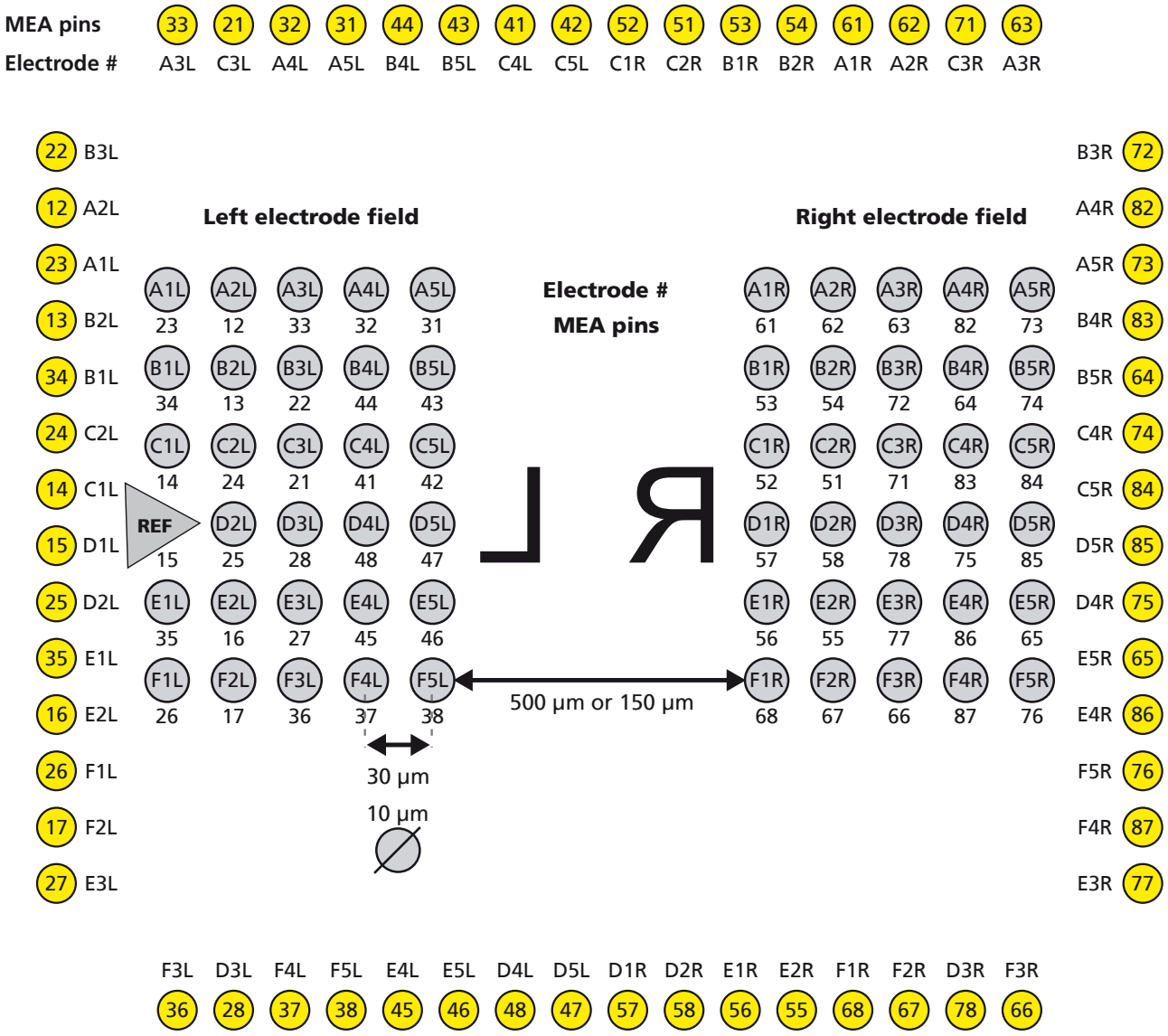
Electrode Layout



The first letter of the electrode number code refers to the row number, the digit is the column number, and the second letter refers to the electrode field (left or right) of the 60HighDenseMEA. The specified MEA pin numbers are the channel numbers that are used in the MC_Rack program. The electrode D1 of the left electrode field, connected to channel 15 in MC_Rack is missing. It is replaced by a big internal reference electrode.

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60HexaMEA40/10

60HexaMEA40/10iR-ITO

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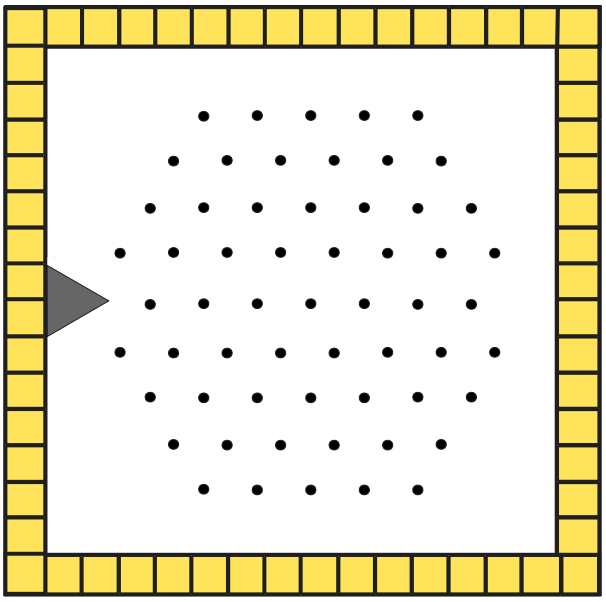
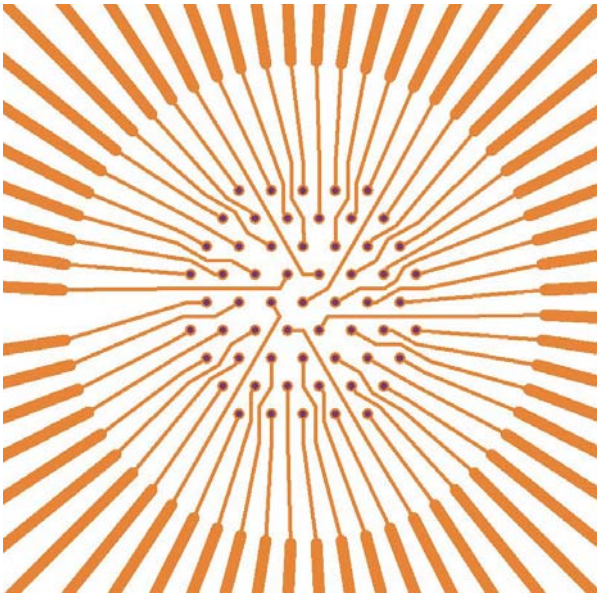
60 Hexa Microelectrode Array





Technical Specifications 60HexaMEA40/10

Temperature compatibility	0 - 125 °C
Dimension (W x D x H)	49 mm x 49 mm x 1 mm
Base material	Glass
Contact pads and track material	ITO (Indium tin oxide)
Electrode diameter	10 µm
Interelectrode distance (centre to centre)	40 µm
Electrode height	Planar
Electrode type	TiN (Titanium nitride)
Isolation type	Silicon nitride 500 nm (PEVCD)
Electrode impedance	Approximately 250 - 400 kΩ
Electrode layout grid	Hexagonal
Number of recording electrodes	59
Number of reference electrodes	1 internal reference electrode (iR)
MC_Rack:	
Source layout in “Data Source Setup”	2 dim (MEA)
Channel map	HexaMEA40/10.cmp

MEA perfusion chamber	(w/o)	Without ring
	(gr)	Glass ring: ID +/- 19 mm, OD 24 mm, height 6 / 12 mm
	(pr)	Plastic ring without thread: ID 26.5 mm, OD 30 mm, height 6 / 3 mm
	(pr-T)	Plastic ring with thread: ID 26 mm, OD 30 mm, height 6 / 15 mm

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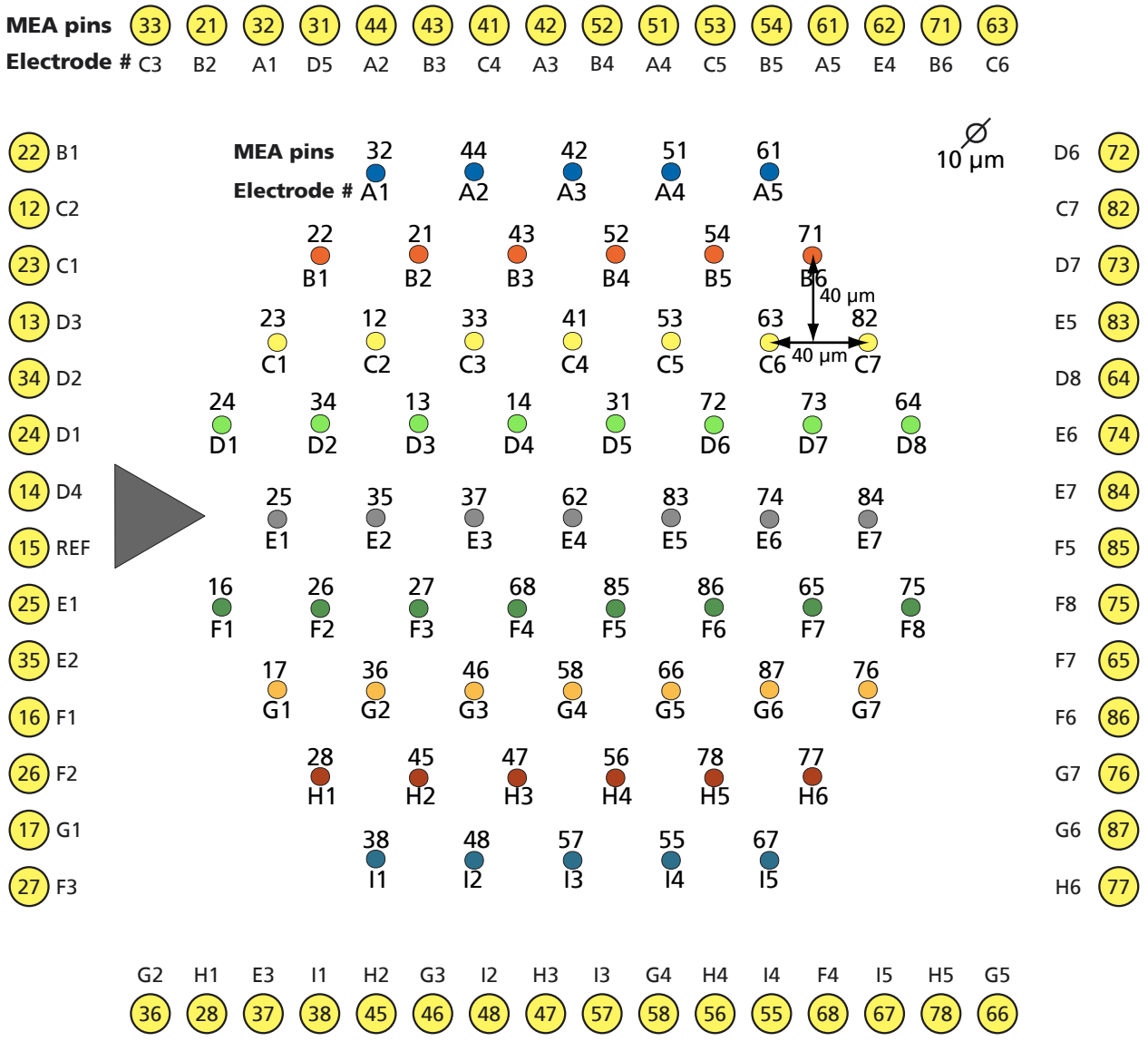
60HexaMEA40/10

60HexaMEA40/10iR-ITO

Electrode Layout



The letter-digit code is the electrode identifier and refers to the position of the electrode in the hexa grid. The specified MEA amplifier pin numbers are the channel numbers that are used in MC_Rack.

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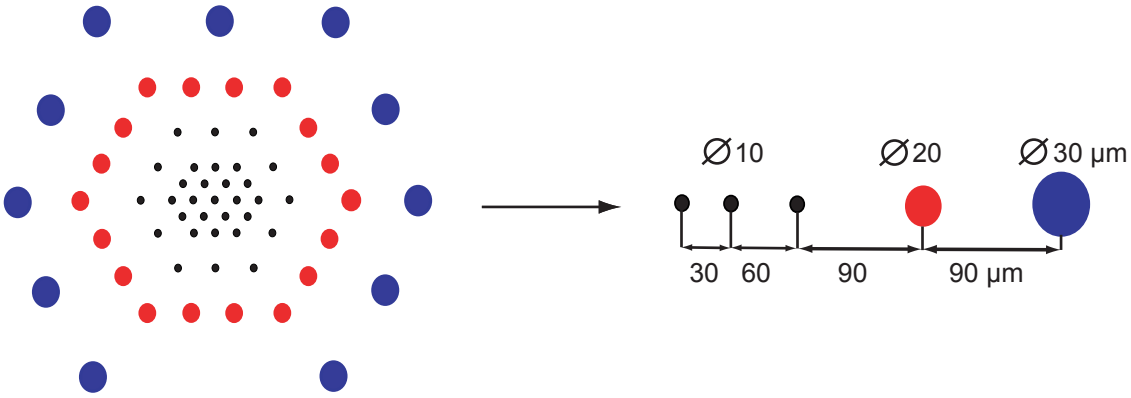
60HexaMEA

60HexaMEA-ITO
60HexaMEA-Ti

60 Hexa Microelectrode Array



Technical Specifications 60HexaMEA

Temperature compatibility	0 - 125 °C
Dimension (W x D x H)	49 mm x 49 mm x 1 mm
Thickness (region of electrodes)	
Base material	Glass
Contact pads	Indium tin oxide (ITO) or Titanium nitride (TiN)
Track material	Indium tin oxide (ITO) or Titanium (Ti)
Electrode diameter	10, 20, 30 µm
Interelectrode distance (centre to centre)	30, 60, 90 µm
Electrode height	Planar
Electrode type	Titanium nitride (TiN)
Isolation type	Silicon nitride 500 nm (PEVCD)
Electrode impedance	30 kΩ - 50 kΩ for 30 µm electrodes, 250 - 400 kΩ for 10 and 20 µm electrodes
Electrode layout grid	hexagonal
Number of recording electrodes	60
Number of reference electrodes	without internal reference electrode
MC_Rack:	
Source Layout in Data Source Setup	2 dim. (MEA)
MCS Channel map	HexaMEA.cmp

MEA perfusion chamber	(w/o)	Without ring
	(gr)	Glass ring: ID +/- 19 mm, OD 24 mm, height 6 / 12 mm
	(pr)	Plastic ring without thread: ID 26.5 mm, OD 30 mm, height 6 / 3 mm
	(pr-T)	Plastic ring with thread: ID 26 mm, OD 30 mm, height 6 / 15 mm

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60HexaMEA

60HexaMEA-ITO
60HexaMEA-Ti

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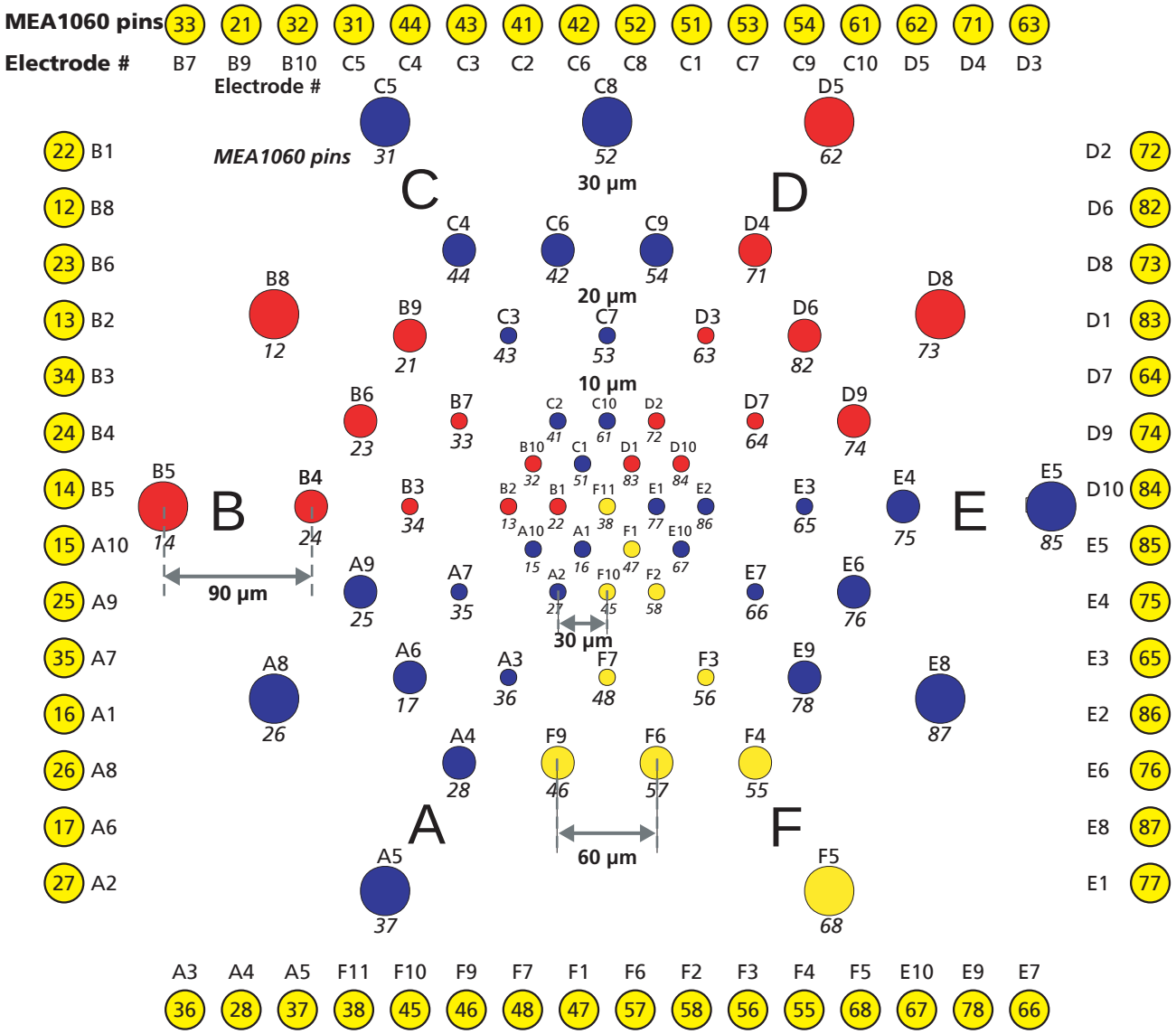
Electrode Layout



The letter-digit code is the electrode identifier and refers to the position of the electrode in the hexa grid. The specified MEA amplifier pin numbers are the channel numbers that are used in MC_Rack.

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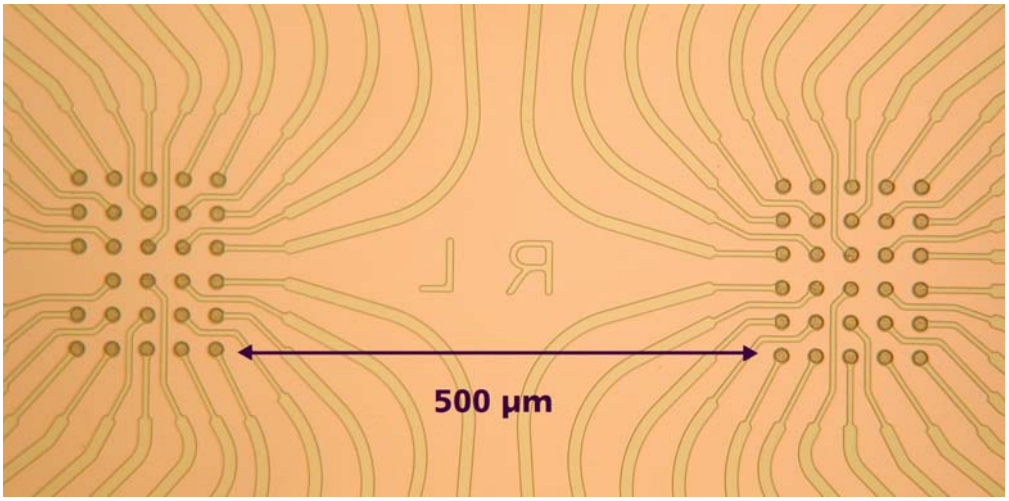
60ThinMEA30/10iR-ITO

60ThinMEA30/10iR-ITO



Technical Specifications 60ThinMEA30/10iR-ITO

Temperature compartibility	0 - 125 °C
Dimension (W x D x H)	49 mm x 49 mm x 1 mm
“Thickness”	180 µm (Glass part)
Base material	Glass on ceramic carrier
Contact pads and track material	ITO (Indium tin oxide)
Electrode diameter	10 µm
Interelectrode distance (centre to centre)	30 µm
Distance between electrode fields	500 µm
Electrode height	Planar
Electrode type	TiN (Titanium nitride)
Isolation type	Silicon nitride 500 nm (PEVCD)
Electrode impedance	250 - 400 kΩ
Electrode layout grid	2 x (5 x 6)
Number of recording electrodes	59
Number of reference electrodes	1 internal reference electrode
MC_Rack	
Source layout in “Data Source Setup”	2 dim. (MEA)
Channel map	HighDenseMEA.cmp HighDenseMEA_L.cmp HighDenseMEA_R.cmp

MEA perfusion chamber	(w/o)	Without ring
	(gr)	Glass ring: ID +/- 19 mm, OD 24 mm, height 6 / 12 mm
	(pr)	Plastic ring without thread: ID 26.5 mm, OD 30 mm, height 6 / 3 mm
	(pr-T)	Plastic ring with thread: ID 26 mm, OD 30 mm, height 6 / 15 mm

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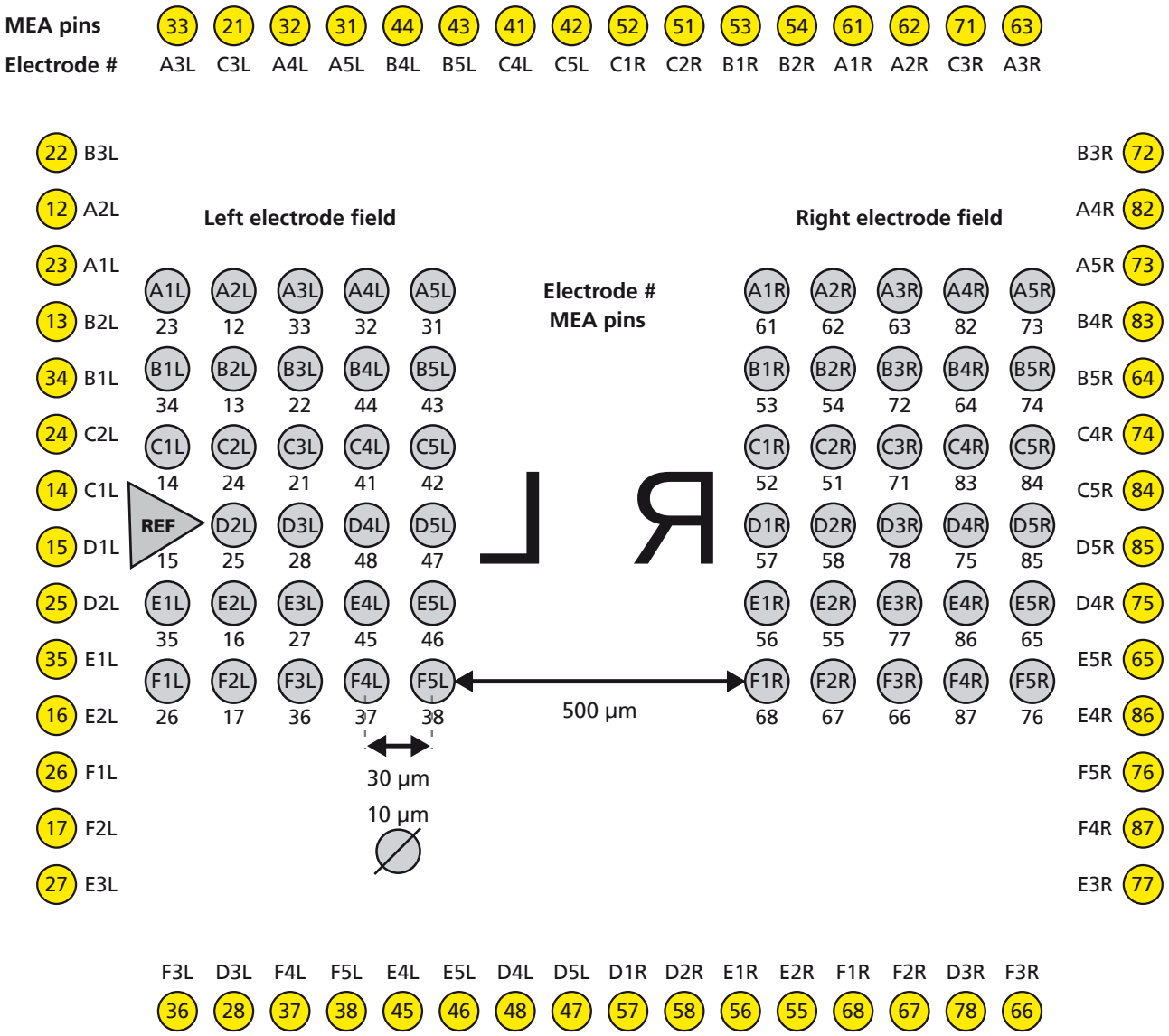
60ThinMEA30/10iR-ITO

60ThinMEA30/10iR-ITO



The first letter of the electrode number code refers to the row number, the digit is the column number, and the second letter refers to the electrode field (left or right) of the 60ThinMEA30/10iR-Ti.
The specified MEA pin numbers are the channel numbers that are used in the MC_Rack program.
The electrode D1 of the left electrode field, connected to channel 15 in MC_Rack is missing.
It is replaced by a big internal reference electrode.

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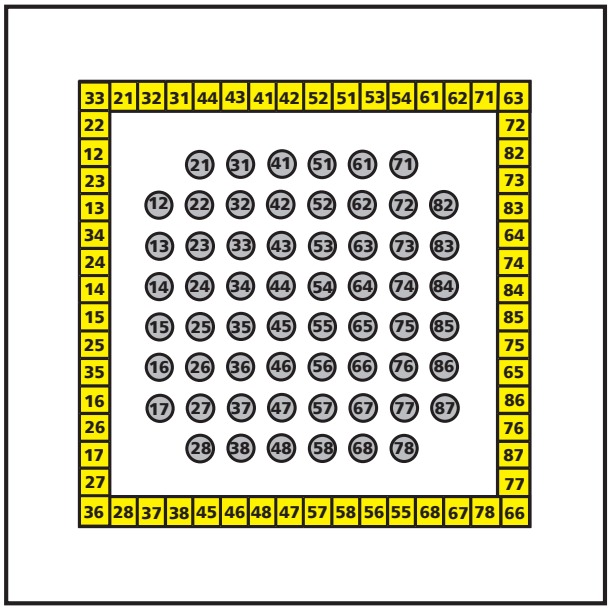
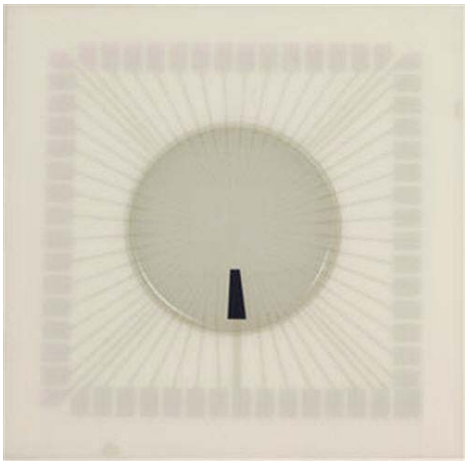
60ThinMEA

60ThinMEA30/10-ITO
60ThinMEA100/10-ITO
60ThinMEA200/30iR-ITO





60 electrode Thin Microelectrode Array with 8 x 8 layout.
The electrodes are embedded in a very thin glass substrate on a robust ceramic carrier. Contact pads and tracks are made from transparent indium tin oxide for high resolution imaging.

Technical Specifications 60ThinMEA

Temperature compatibility	0 - 125 °C
Dimension (W x D x H)	49 mm x 49 mm x 1 mm
“Thickness”	180 µm (Glass part)
Base material	Glass on ceramic carrier
Contact pads and track material	ITO (Indium tin oxide)
Electrode diameter	10 or 30 µm
Interelectrode distance (centre to centre)	100 or 200 µm
Electrode height	Planar
Electrode type	TiN (Titanium nitride)
Isolation type	Silicon nitride 500 nm (PEVCD)
Electrode impedance	30 - 50 kΩ for 30 µm, 250 - 400 kΩ for 10 µm electrodes
Electrode layout grid	8 x 8
Number of recording electrodes	59 (with iR) or 60 (without iR)
Number of reference electrodes	1 internal reference electrode iR: 60ThinMEA200/30iR-ITO or without internal reference electrode: 60ThinMEA100/10-ITO 60ThinMEA30/10-ITO
MC_Rack	
Source layout in “Data Source Setup”	2 dim. (MEA)
Channel map	Default

MEA perfusion chamber	(w/o)	Without ring
	(gr)	Glass ring: ID +/- 19 mm, OD 24 mm, height 6 / 12 mm
	(pr)	Plastic ring without thread: ID 26.5 mm, OD 30 mm, height 6 / 3 mm
	(pr-T)	Plastic ring with thread: ID 26 mm, OD 30 mm, height 6 / 15 mm

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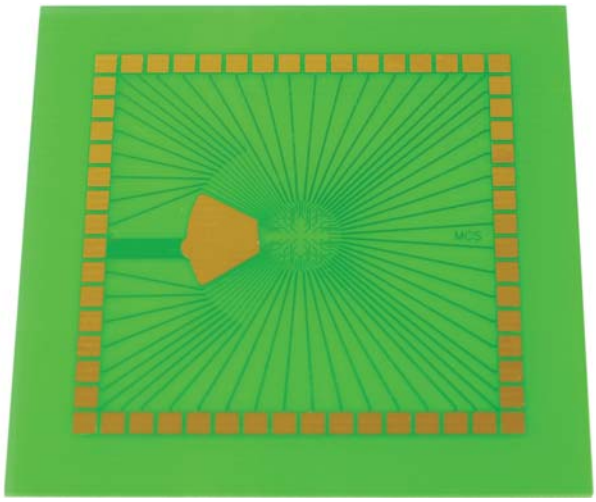
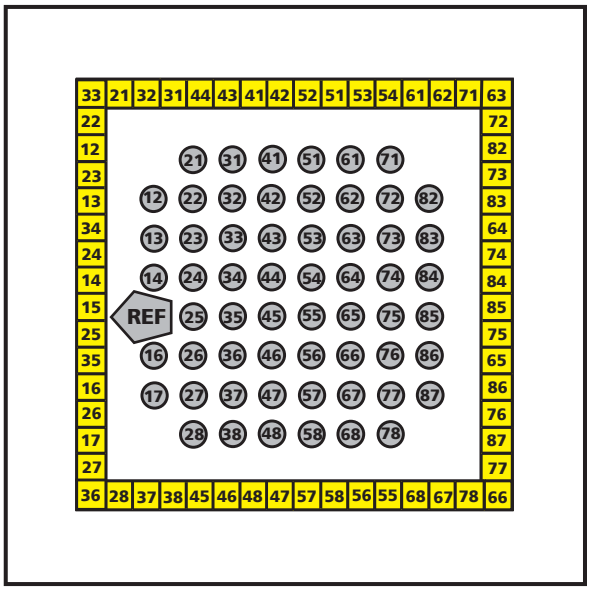
60EcoMEA

Low priced Microelectrode Array on PCB Base



60EcoMEA on PCB base with 8 x 8 standard electrode layout.



Technical Specifications 60EcoMEA

Temperature compatibility	0 - 125 °C
Dimension (W x D x H)	49 mm x 49 mm x 1 mm
Base material	PCB (Printed circuit board)
Contact pads and track material	Gold
Electrode diameter	100 µm
Interelectrode distance (centre to centre)	700 µm
Electrode height	Planar
Electrode type	Gold
Isolation type	PCB (Printed circuit board)
Electrode impedance	approx. 30 kΩ
Electrode layout grid	8 x 8
Number of recording electrodes	59
Number of reference electrodes	1 internal reference electrode
MC_Rack	
Source layout in “Data Source Setup”	2 dim. (MEA)
Channel map	Default

MEA perfusion chamber	(w/o)	Without ring
	(gr)	Glass ring: ID +/- 19 mm, OD 24 mm, height 6 / 12 mm
	(pr)	Plastic ring without thread: ID 26.5 mm, OD 30 mm, height 6 / 3 mm
	(pr-T)	Plastic ring with thread: ID 26 mm, OD 30 mm, height 6 / 15 mm

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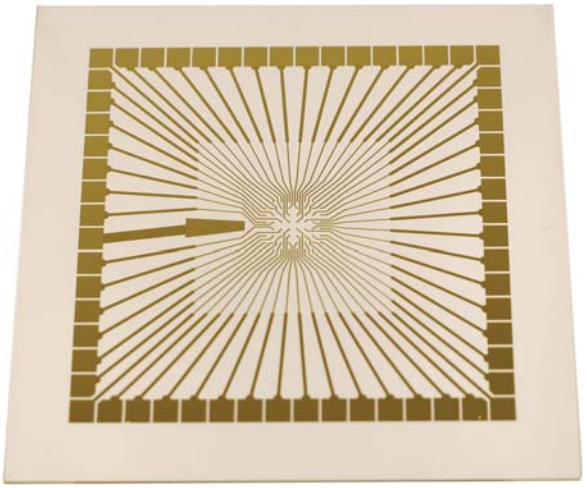
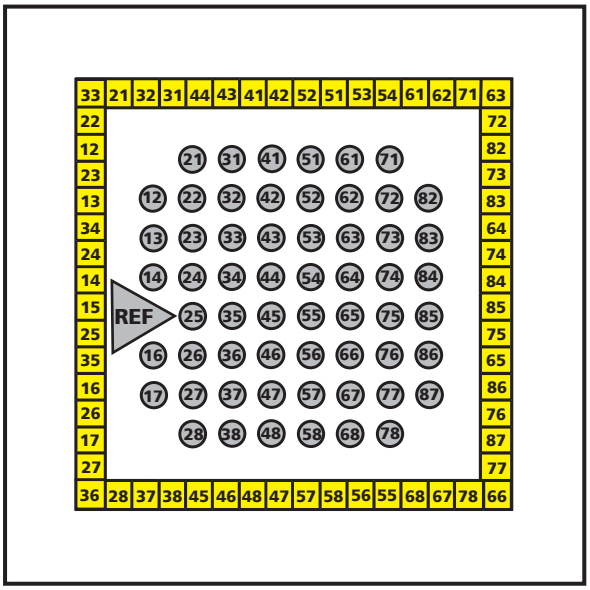
60EcoMEA-Glass

Low priced Microelectrode Array on Glass Base



60EcoMEA on glass base with 8 x 8 standard electrode layout.



Technical Specifications 60EcoMEA-Glass

Temperature compatibility	0 - 125 °C
Dimension (W x D x H)	49 mm x 49 mm x 1 mm
Base material	Glass
Contact pads and track material	Gold
Electrode diameter	100 µm
Interelectrode distance (centre to centre)	700 µm
Electrode height	Planar
Electrode type	Gold
Isolation type	SU-8 (photoresist, 1 - 2 µm)
Electrode impedance	approx. 30 kΩ
Electrode layout grid	8 x 8
Number of recording electrodes	59
Number of reference electrodes	1 internal reference electrode
MC_Rack	
Source layout in “Data Source Setup”	2 dim. (MEA)
Channel map	Default

MEA perfusion chamber	(w/o)	Without ring
	(gr)	Glass ring: ID +/- 19 mm, OD 24 mm, height 6 / 12 mm
	(pr)	Plastic ring without thread: ID 26.5 mm, OD 30 mm, height 6 / 3 mm
	(pr-T)	Plastic ring with thread: ID 26 mm, OD 30 mm, height 6 / 15 mm

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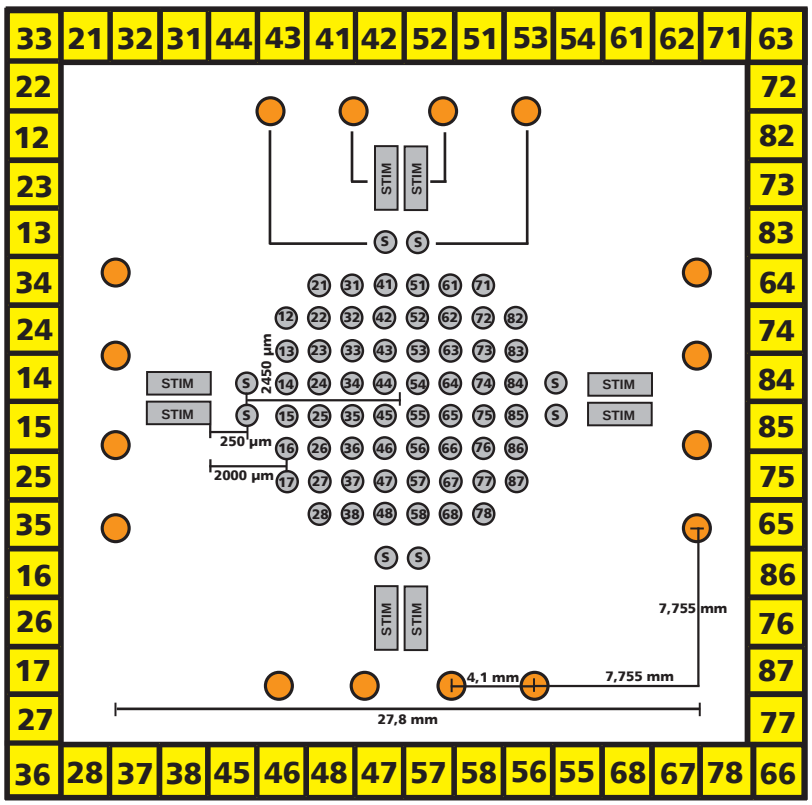
60StimMEA

60StimMEA200/30-ITO
60StimMEA200/30-Ti



60 electrodes Microelectrode Array
with 16 additional stimulation electrodes.

Electrode layout: Standard 8 x 8 grid

For use with **MEA-STIM-ADPT**:

Adapter for MEAs with 16 additional stimulation electrodes and for MEA1060 amplifiers.

Contact pad for stimulation adapter MEA-STIM-ADPT
Diameter of contact pad 2 mm
Distance between contact pads 4.1 mm (Centre to centre)

Technical Specifications 60 Electrode MEA with 16 additional Stimulation Electrodes

Temperature compatibility		0 - 125 °C
Dimension (W x D x H)		49 mm x 49 mm x 1 mm
Base material		Glass
Track material		Indium tin oxide (ITO) or Titanium (Ti)
Contact pads		Indium tin oxide (ITO) or Titanium nitride (TiN)
Electrode diameter		30 µm
Interelectrode distance (centre to centre)		200 µm
Electrode height		Planar
Electrode type		Titanium nitride (TiN) electrodes
Isolation type		Silicon nitride 500 nm (PEVCD)
Electrode impedance		30 - 50 kΩ
Electrode layout grid		8 x 8 and additional 4 pairs of large stimulation electrodes (STIM = 70 x 250 µm) 4 pairs of small stimulation electrodes (S = 30 µm)
Number of recording electrodes		60
Number of reference electrodes		Without internal reference electrode
MC_Rack Source layout in “Data Source Setup” Channel map		 2 dim. (MEA) Default
MEA perfusion chamber	(w/o) (gr)	without ring Glass ring: ID +/-19 mm, OD 24 mm, height 6 / 12 mm

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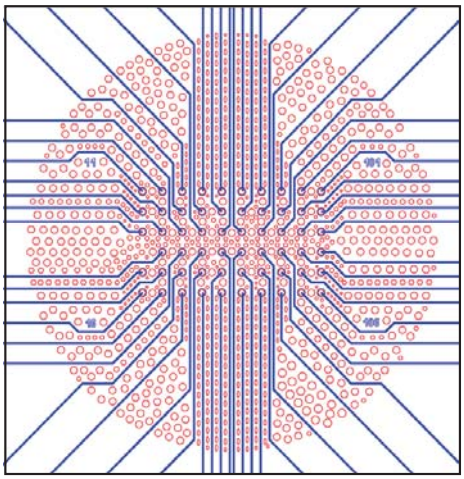
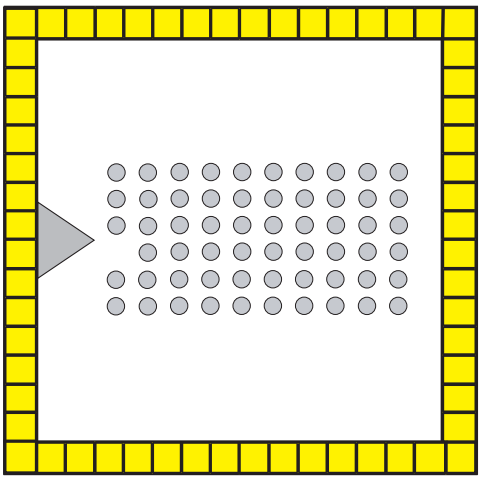
60pMEA100/30iR-Ti

60pMEA100/30iR-Ti





Perforated Microelectrode Array with 6 x 10 electrode layout grid. Perforated MEAs for use with MEA1060 amplifiers equipped with a perfusion ground plate (PGP) or a MEA2100 headstage with a perfusion element (PE). The perforation allows a perfusion of the tissue from both sides of the pMEA.

Technical Specifications 60pMEA100/30iR-Ti

Temperature compatibility	10 - 50 °C
Dimension (W x D x H)	49 mm x 49 mm x 1 mm
Base material	Polyimide foil (2611) on glass or ceramic carrier
Perforation:	
Diameter of innermost area	2 mm
Total area of holes	19% (according to 2 mm)
Diameter of holes	5, 6, 7.5, 9, 10, 12.5, 15, 17.7, 20
Contact pads	TiAu (Titan, Gold)
Track material	TiAuTi (Titan, Gold, Titan)
Electrode diameter	30 µm
Interelectrode distance (centre to centre)	100 µm
Electrode height	Planar
Electrode type	TiN (Titanium nitride)
Isolation type	Polyimide foil (2610) isolator
Electrode impedance	30 - 50 kΩ
Electrode layout grid	6 x 10
Number of electrodes	60
Reference electrodes	with internal reference (iR)
MC_Rack	
Source layout in “Data Source Setup”	2 dim. (MEA)
Channel map	pMEA 6x10.cmp

Cleaning

Rinse with distilled water. Do **not** use ultrasonic bath!
These pMEAs are not heat stable, and should **not** be autoclaved!

MEA perfusion chamber

(w/o)	Without ring
(gr)	Glass ring: ID +/- 19 mm, OD 24 mm, height 6 / 12 mm
(pr)	Plastic ring without thread: ID 26.5 mm, OD 30 mm, height 6 / 3 mm
(pr-T)	Plastic ring with thread: ID 26 mm, OD 30 mm, height 6 / 15 mm

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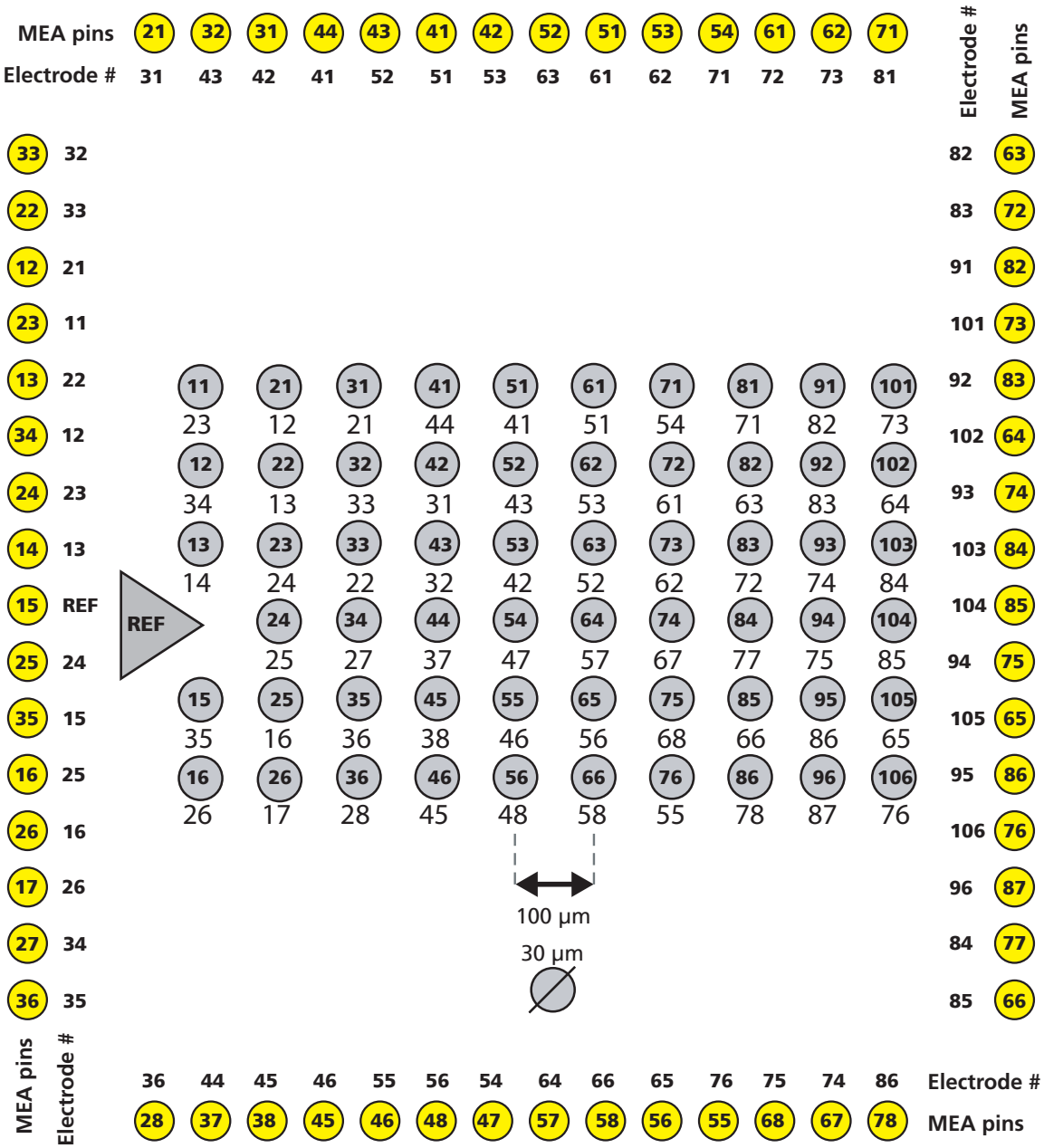
60pMEA100/30iR-Ti

60pMEA100/30iR-Ti



The first number of the electrode number code refers to the column number, the second number is the row number of the 60pMEA100/30iR-Ti. The specified MEA pin numbers are the channel numbers that are used in the MC_Rack program, when using the 2 dim. source layout in “Data Source Setup”. The electrode 14 is missing. It is replaced by a big internal reference electrode, and connected to MC_Rack channel number 15.

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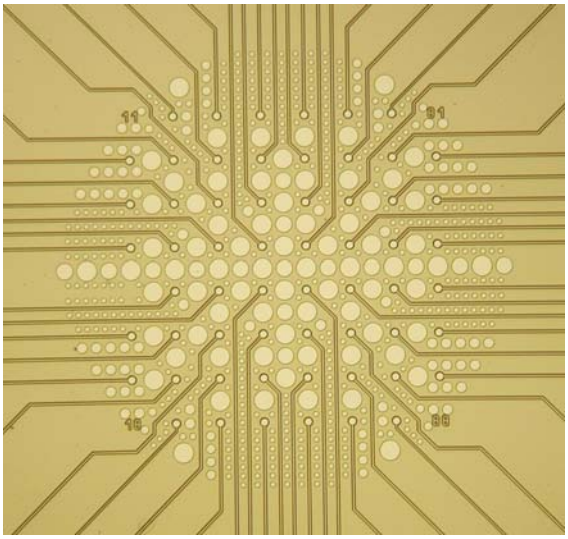
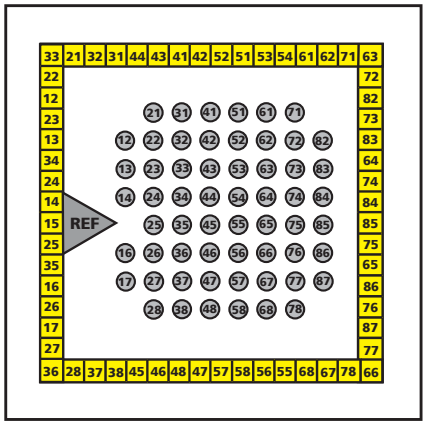
60pMEA200/30iR-Ti

60pMEA200/30iR-Ti





Perforated Microelectrode Array in 8 x 8 layout grid for use with MEA1060 amplifiers equipped with a perfusion ground plate (PGP) or a MEA2100 headstage equipped with a perfusion element (PE). The perforation allows the perfusion of the tissue from both sides of the pMEA.

Technical Specifications 60pMEA200/30iR-Ti

Temperature compatibility	10 - 50 °C
Dimension (W x D x H)	49 mm x 49 mm x 1 mm
Base material	Polyimide foil (2611) on glass or ceramic carrier
Perforation:	
Diameter of innermost area	2 mm
Total area of holes	24% (according to 2 mm)
Diameter of holes	10, 12, 12.5, 17, 19, 22, 23.3, 23.5, 36, 44 µm
Contact pads	TiAu (Titan, Gold)
Track material	TiAuTi (Titan, Gold, Titan)
Electrode diameter	30 µm
Interelectrode distance (centre to centre)	200 µm
Electrode height	Planar
Electrode type	TiN (Titanium nitride)
Isolation type	Polyimide foil (2610) isolator
Electrode impedance	30 - 50 kΩ
Electrode layout grid	8 x 8
Number of recording electrodes	59
Number of reference electrodes	1 internal reference electrode (iR)
MC_Rack	
Source layout in “Data Source Setup”	2 dim. (MEA)
Channel map	Default

Cleaning

Rinse with distilled water. Do **not** use ultrasonic bath!
These pMEAs are not heat stable, and should **not** be autoclaved!

MEA perfusion chamber	(w/o)	Without ring
	(gr)	Glass ring: ID +/- 19 mm, OD 24 mm, height 6 / 12 mm
	(pr)	Plastic ring without thread: ID 26.5 mm, OD 30 mm, height 6 / 3 mm
	(pr-T)	Plastic ring with thread: ID 26 mm, OD 30 mm, height 6 / 15 mm

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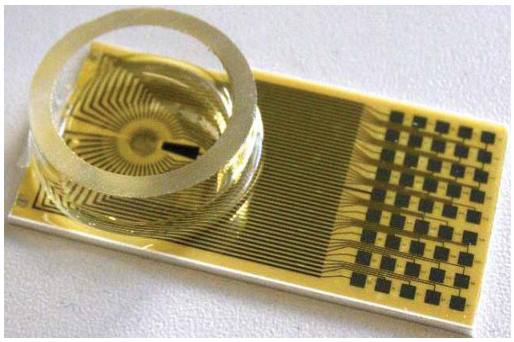
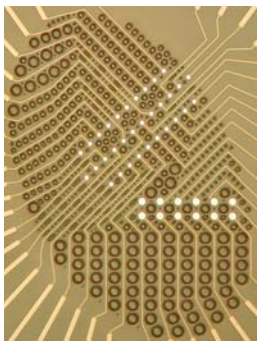
pMEA32S12 Layout 1

Perforated MEA for use with MEA2100-32- and USB-MEA32-STIM4-System





Technical Specifications pMEA32S12 Layout 1

Temperature compatibility	10 - 50 °C
Dimension (W x D x H)	49 mm x 25 mm x 1.8 mm
Base material	Polyimide foil on ceramic carrier with perforation
Perforation:	
Total area of holes	0.8 mm ^{2}
Diameter of the holes	90, 75, 50, 30, 20 µm
Track material	Ti (Titanium)
Contact pads	TiN (Titanium nitride)
Electrode diameter	30 µm (recording electrodes) 50 µm (stimulation electrodes)
Interelectrode distance (centre to centre)	90 µm and 150 µm (recording electrodes), 100 µm and 125 µm (stimulation electrodes)
Electrode height	Planar
Electrode type	TiN (Titanium nitride) electrodes
Isolation type	Polyimide foil
Electrode impedance	Approximately 30 - 50 kΩ
Electrode layout grid	1 x 10 + 1 x 12 + 1 x 10 (recording electrodes), 2 x 6 (stimulation electrodes)
Number of recording electrodes	32
Number of stimulation electrodes	12
Number of reference electrodes	1 internal reference electrode
MC_Rack “Source layout” in “Data Source Setup” Channel map	Configuration (MEA2100-32) 1 dimensional, no digital channel (USB-MEA32-STIM4) pMEA-32S12-L1_12x3.cmp

Cleaning

Rinse with distilled water.
Do not use ultrasonic bath!
Do not autoclave or sterilize pMEAs by heat.
These MEA types are not heat-stable and will be irreversibly damaged!

pMEA perfusion chamber

(w/o) Without ring
(gr) Glass ring: ID +/- 19 mm, OD 24 mm, height 6 / 12 mm

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pMEA32S12 Layout 1

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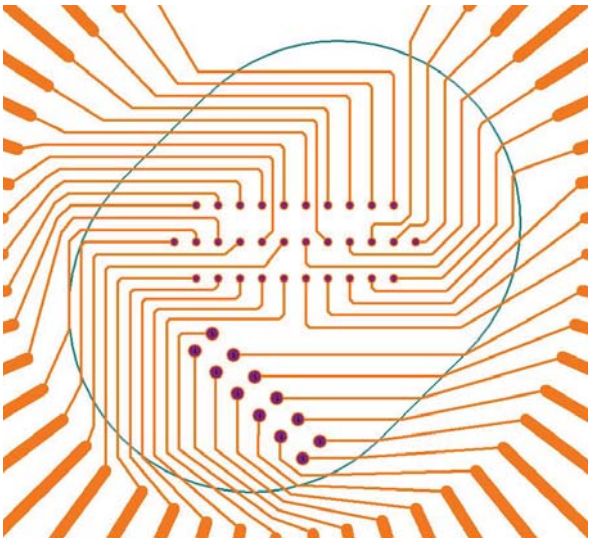
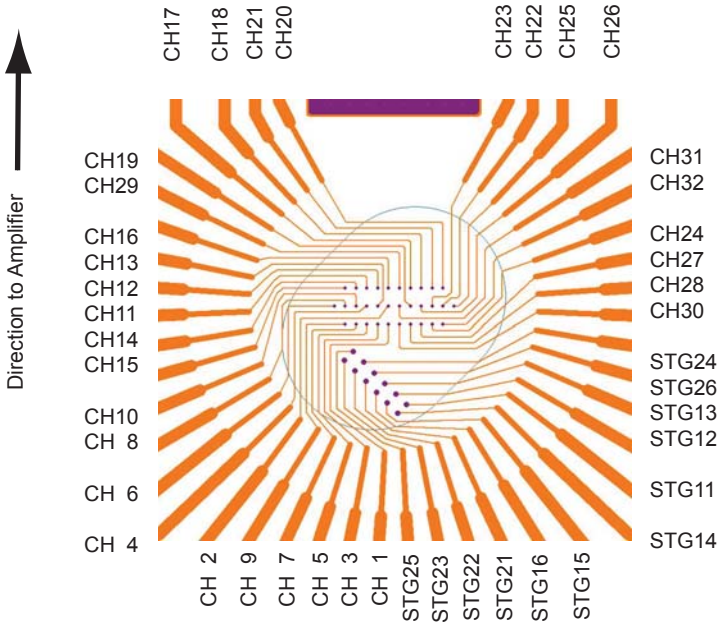
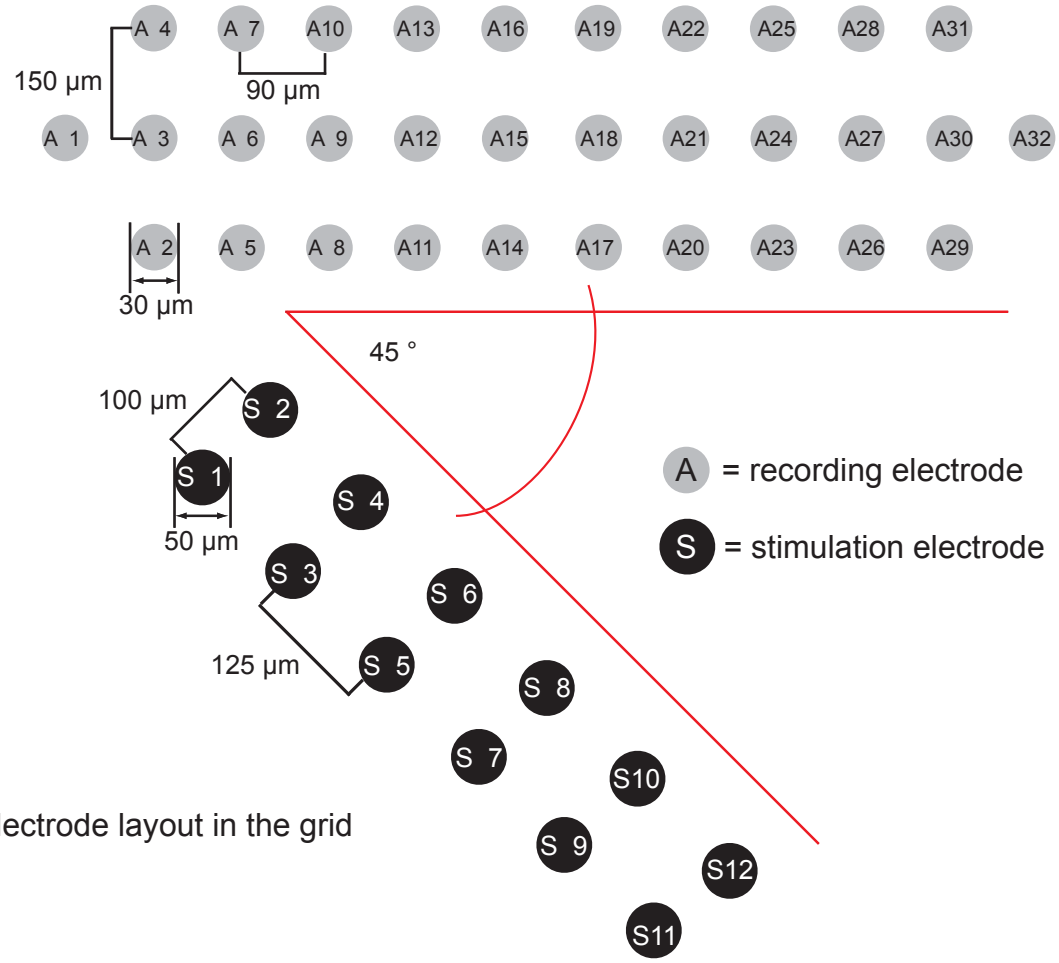
Perforated MEA for use with MEA2100-32- and USB-MEA32-STIM4-System



The oval area of the pMEA chip is perforated





Electrode layout in the grid

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pMEA32S12 Layout 1

Perforated MEA for use with MEA2100-32- and USB-MEA32-STIM4-System

MC_Rack channel map: pMEA-32S12-L1_12x3.cmp

	15	14	11	12	16	29	17	18	21	20	
6	8	10	4	13	2	31	19	26	23	22	25
	9	7	5	3	1	30	28	27	24	32	

The MC_Rack channel map is build analog to the layout of the recording electrodes in the grid.

	A 4	A 7	A10	A13	A16	A19	A22	A25	A28	A31	
A 1	A 3	A 6	A 9	A12	A15	A18	A21	A24	A27	A30	A32
	A 2	A 5	A 8	A11	A14	A17	A20	A23	A26	A29	

Table:
Correlation of MC_Rack channels and recording electrodes

A = Number of recording electrode, CH = Channel number in MC_Rack
S = Number of stimulation electrode, STG = Internal stimulus generator connection
REF = Reference electrode

S 1	STG 23	STG 16	S 7
S 2	STG 25	STG 13	S 8
S 3	STG 22	STG 15	S 9
S 4	STG 24	STG 12	S 10
S 5	STG 21	STG 14	S 11
S 6	STG 26	STG 11	S 12

REF

A 1	CH 6	CH 30	A 17
A 2	CH 9	CH 31	A 18
A 3	CH 8	CH 29	A 19
A 4	CH 15	CH 28	A 20
A 5	CH 7	CH 19	A 21
A 6	CH 10	CH 17	A 22
A 7	CH 14	CH 27	A 23
A 8	CH 5	CH 26	A 24
A 9	CH 4	CH 18	A 25
A 10	CH 11	CH 24	A 26
A 11	CH 3	CH 23	A 27
A 12	CH 13	CH 21	A 28
A 13	CH 12	CH 32	A 29
A 14	CH 1	CH 22	A 30
A 15	CH 2	CH 20	A 31
A 16	CH 16	CH 25	A 32

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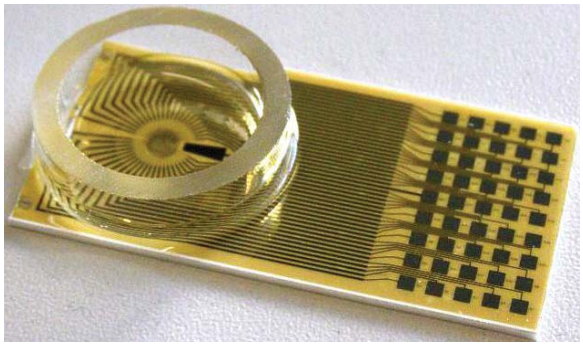
pMEA32S12 Layout 2

Perforated MEA for use with MEA2100-32- and USB-MEA32-STIM4-System



Technical Specifications pMEA32S12 Layout 2

Temperature compatibility	10 - 50 °C
Dimension (W x D x H)	49 mm x 25 mm x 1.8 mm
Base material	Polyimide foil on ceramic carrier with perforation
Perforation:	
Total area of holes	0.8 mm ^{2}
Diameter of the holes	90, 75, 50, 30, 20 µm
Track material	Ti (Titanium)
Contact pads	TiN (Titanium nitride)
Electrode diameter	30 µm (recording electrodes) 50 µm (stimulation electrodes)
Interelectrode distance (centre to centre)	90 µm and 150 µm (recording electrodes), 90 µm and 150 µm (stimulation electrodes)
Electrode height	Planar
Electrode type	TiN (Titanium nitride) electrodes
Isolation type	Polyimide foil
Electrode impedance	Approximately 30 - 50 kΩ
Electrode layout grid	1 x 10 + 1 x 12 + 1 x 10 (recording electrodes), 6 x 2 (stimulation electrodes)
Number of recording electrodes	32
Number of stimulation electrodes	12
Number of reference electrodes	1 internal reference electrode
MC_Rack “Source layout” in “Data Source Setup” Channel map	Configuration (MEA2100-32) 1 dimensional, no digital channel (USB-MEA32-STIM4) pMEA-32S12-L2_12x3.cmp
Cleaning	Rinse with distilled water. Do not use ultrasonic bath! Do not autoclave or sterilize pMEAs by heat. These MEA types are not heat-stable and will be rreversibly damaged!
pMEA perfusion chamber	(w/o) Without ring (gr) Glass ring: ID +/- 19 mm, OD 24 mm, height 6 / 12 mm

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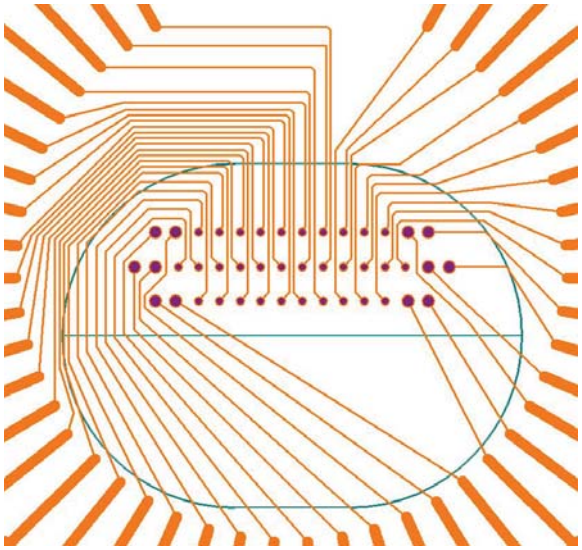
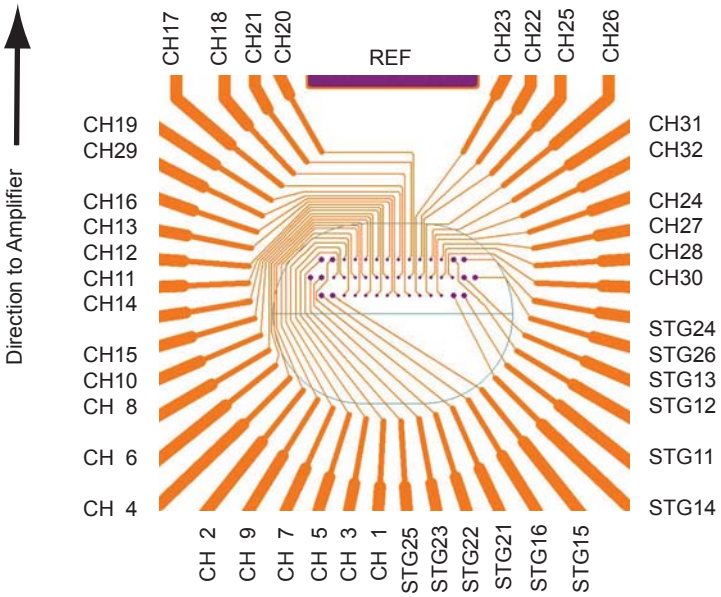
pMEA32S12 Layout 2

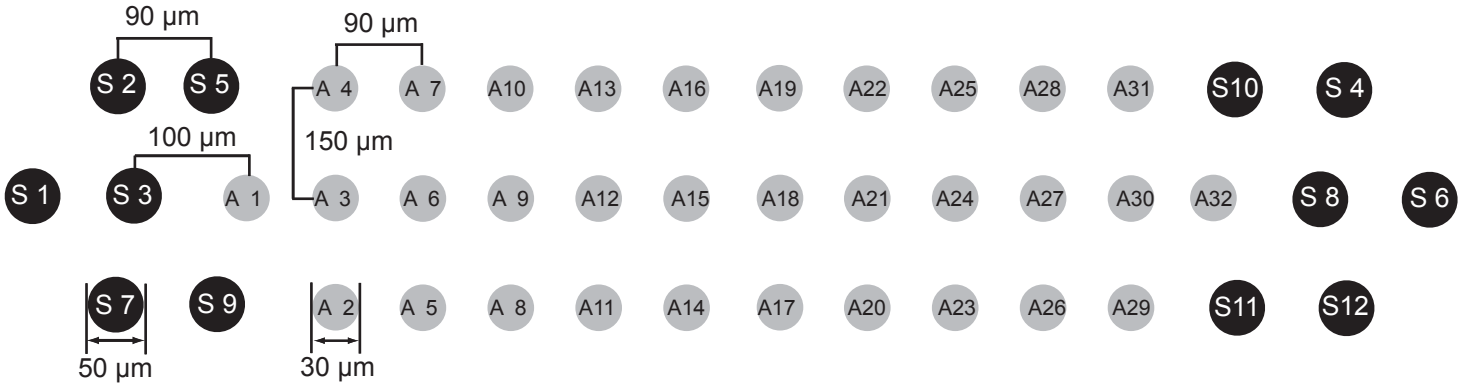
Perforated MEA for use with MEA2100-32- and USB-MEA32-STIM4-System



The oval area of the pMEA chip is perforated



Electrode layout in the grid



A = recording electrode

S = stimulation electrode

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pMEA32S12 Layout 2

Perforated MEA for use with MEA2100-32- and USB-MEA32-STIM4-System

MC_Rack channel map: pMEA-32S12-L2_12x3.cmp

	5	2	8	14	13	19	21	22	31	27	
1	3	9	6	15	12	17	20	25	32	28	30
	7	4	10	11	16	29	18	23	26	24	

The MC_Rack channel map is build analog to the layout of the recording electrodes in the grid.

	A 4	A 7	A10	A13	A16	A19	A22	A25	A28	A31	
A 1	A 3	A 6	A 9	A12	A15	A18	A21	A24	A27	A30	A32
	A 2	A 5	A 8	A11	A14	A17	A20	A23	A26	A29	

Table:
Correlation of MC_Rack channels and recording electrodes

A = Number of recording electrode, CH = Channel number in MC_Rack
S = Number of stimulation electrode, STG = Internal stimulus generator connection,
REF = Reference electrode

S 1	STG 23	REF	STG 16	S 7
S 2	STG 25		STG 13	S 8
S 3	STG 22		STG 15	S 9
S 4	STG 24		STG 12	S 10
S 5	STG 21		STG 14	S 11
S 6	STG 26		STG 11	S 12

A 9	CH 6	CH 30	A 32
A 6	CH 9	CH 31	A 28
A 10	CH 8	CH 29	A 17
A 12	CH 15	CH 28	A 30
A 2	CH 7	CH 19	A 19
A 8	CH 10	CH 17	A 18
A 13	CH 14	CH 27	A 31
A 4	CH 5	CH 26	A 26
A 5	CH 4	CH 18	A 20
A 11	CH 11	CH 24	A 29
A 3	CH 3	CH 23	A 23
A 16	CH 13	CH 21	A 22
A 15	CH 12	CH 32	A 27
A 1	CH 1	CH 22	A 25
A 7	CH 2	CH 20	A 21
A 14	CH 16	CH 25	A 24

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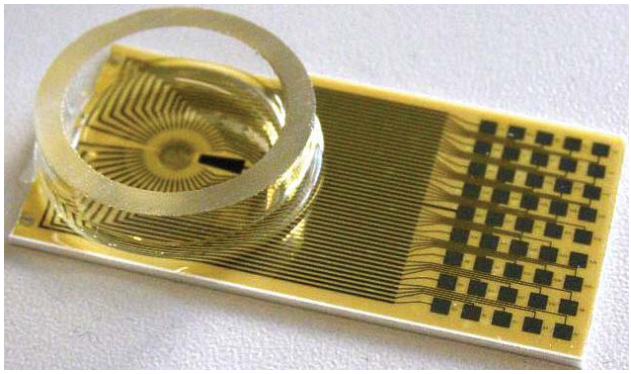
pMEA32S12 Layout 3

Perforated MEA for use with MEA2100-32- and USB-MEA32-STIM4-System



Technical Specifications pMEA32S12 Layout 3

Temperature compatibility	10 - 50 °C
Dimension (W x D x H)	49 mm x 25 mm x 1.8 mm
Base material	Polyimide foil on ceramic carrier with perforation
Perforation:	
Total area of holes	0.8 mm^2
Diameter of the holes	90, 75, 50, 30, 20 µm
Track material	Ti (Titanium)
Contact pads	TiN (Titanium nitride)
Electrode diameter	30 µm (recording electrodes) 50 µm (stimulation electrodes)
Interelectrode distance (centre to centre)	90 µm and 150 µm (recording electrodes), 90 µm and 100 µm (stimulation electrodes)
Electrode height	Planar
Electrode type	TiN (Titanium nitride) electrodes
Isolation type	Polyimide foil
Electrode impedance	Approximately 30 - 50 kΩ
Electrode layout grid	1 x 10 + 1 x 12 + 1 x 10 (recording electrodes), 3 x 4 (stimulation electrodes)
Number of recording electrodes	32
Number of stimulation electrodes	12
Number of reference electrodes	1 internal reference electrode
MC_Rack “Source layout” in “Data Source Setup” Channel map	Configuration (MEA2100-32) 1 dimensional, no digital channel (USB-MEA32-STIM4) pMEA-32S12-L3_12x3.cmp
Cleaning	Rinse with distilled water. Do not use ultrasonic bath! Do not autoclave or sterilize pMEAs by heat. These MEA types are not heat-stable and will be irreversibly damaged!
pMEA perfusion chamber	(w/o) Without ring (gr) Glass ring: ID +/- 19 mm, OD 24 mm, height 6 / 12 mm

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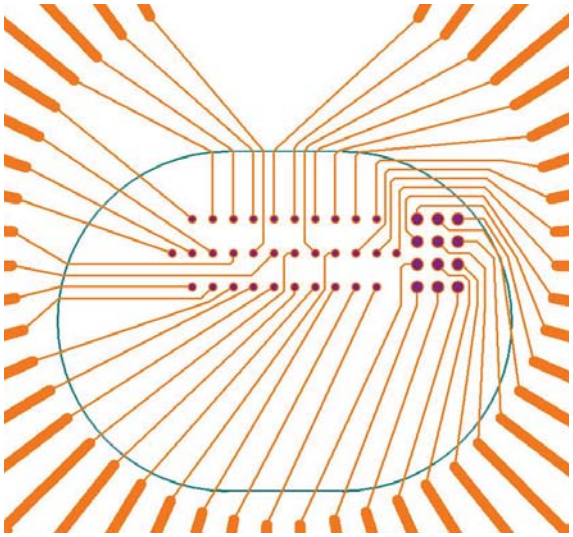
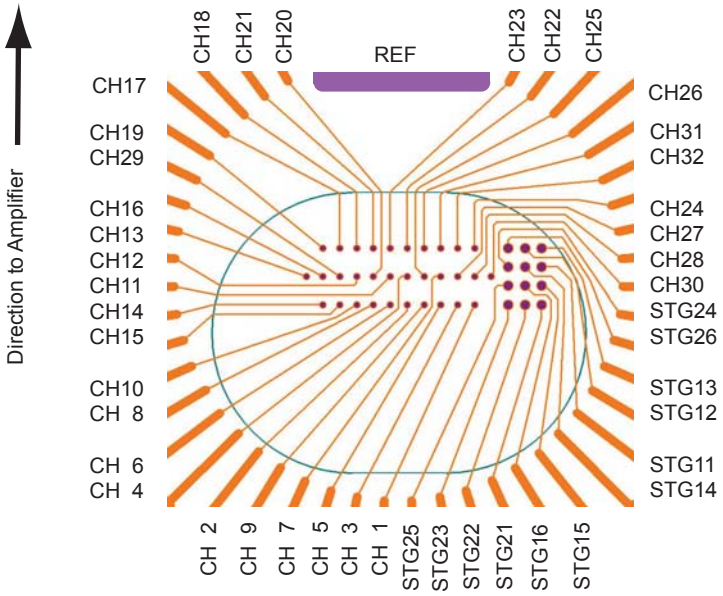
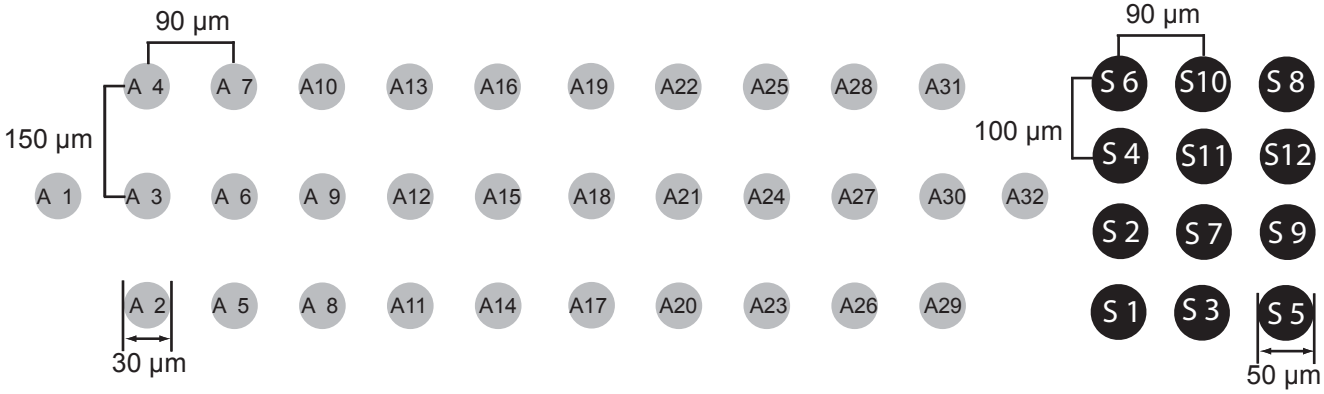
pMEA32S12 Layout 3

Perforated MEA for use with MEA2100-32- and USB-MEA32-STIM4-System



The oval area of the pMEA chip is perforated





A = recording electrode

S = stimulation electrode

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pMEA32S12 Layout 3

Perforated MEA for use with MEA2100-32- and USB-MEA32-STIM4-System

MC_Rack channel map: pMEA-32S12-L3_12x3.cmp

	19	17	18	21	23	22	26	31	32	24	
13	16	29	12	20	11	4	25	7	27	28	30
	14	15	10	8	6	2	9	5	3	1	

The MC_Rack channel map is build analog to the layout of the recording electrode in the grid.

	A 4	A 7	A10	A13	A16	A19	A22	A25	A28	A31	
A 1	A 3	A 6	A 9	A12	A15	A18	A21	A24	A27	A30	A32
	A 2	A 5	A 8	A11	A14	A17	A20	A23	A26	A29	

Table:
Correlation of MC_Rack channels and recording electrodes

A = Number of recording electrode, CH = Channel number in MC_Rack
S = Number of stimulation electrode, STG = Internal stimulus generator connection
REF = Reference electrode

S 1	STG 23	REF	STG 16	S 7
S 2	STG 25		STG 13	S 8
S 3	STG 22		STG 15	S 9
S 4	STG 24		STG 12	S 10
S 5	STG 21		STG 14	S 11
S 6	STG 26		STG 11	S 12
A 14	CH 6		CH 30	A 32
A 20	CH 9		CH 31	A 25
A 11	CH 8		CH 29	A 6
A 5	CH 15		CH 28	A 30
A 24	CH 7		CH 19	A 4
A 8	CH 10		CH 17	A 7
A 2	CH 14		CH 27	A 27
A 23	CH 5		CH 26	A 22
A 18	CH 4		CH 18	A 10
A 15	CH 11		CH 24	A 31
A 26	CH 3		CH 23	A 16
A 1	CH 13		CH 21	A 13
A 9	CH 12		CH 32	A 28
A 29	CH 1		CH 22	A 19
A 17	CH 2		CH 20	A 12
A 3	CH 16		CH 25	A 21

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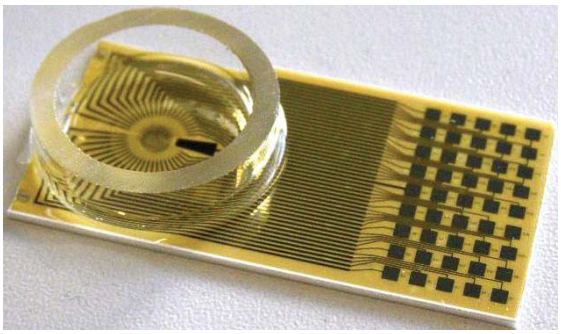
pMEA32S12 Layout 4

Perforated MEA for use with MEA2100-32- and USB-MEA32-STIM4-System



Technical Specifications pMEA32S12 Layout 4

Temperature compatibility	10 - 50 °C
Dimension (W x D x H)	49 mm x 25 mm x 1.8 mm
Base material	Polyimide foil on ceramic carrier with perforation
Perforation:	
Total area of holes	0.8 mm^2
Diameter of the holes	90, 75, 50, 30, 20 µm
Track material	Ti (Titanium)
Contact pads	TiN (Titanium nitride)
Electrode diameter	30 µm (recording electrodes) 50 µm (stimulation electrodes)
Interelectrode distance (centre to centre)	100 µm and 100 µm (recording electrodes), 100 µm and 100 µm (stimulation electrodes)
Electrode height	Planar
Electrode type	TiN (Titanium nitride) electrodes
Isolation type	Polyimide foil
Electrode impedance	Approximately 30 - 50 kΩ
Electrode layout grid	4 x 8 (recording electrodes), 2 x 6 (stimulation electrodes)
Number of recording electrodes	32
Number of stimulation electrodes	12
Number of reference electrodes	1 internal reference electrode
MC_Rack “Source layout” in “Data Source Setup” Channel map	Configuration (MEA2100-32) 1 dimensional, no digital channel (USB-MEA32-STIM4) pMEA-32S12-L4_8x4.cmp

Cleaning

Rinse with distilled water.
Do not use ultrasonic bath!
Do not autoclave or sterilize pMEAs by heat.
These MEA types are not heat-stable and will be rreversibly damaged!

pMEA perfusion chamber

(w/o) Without ring
(gr) Glass ring: ID +/- 19 mm, OD 24 mm, height 6 / 12 mm

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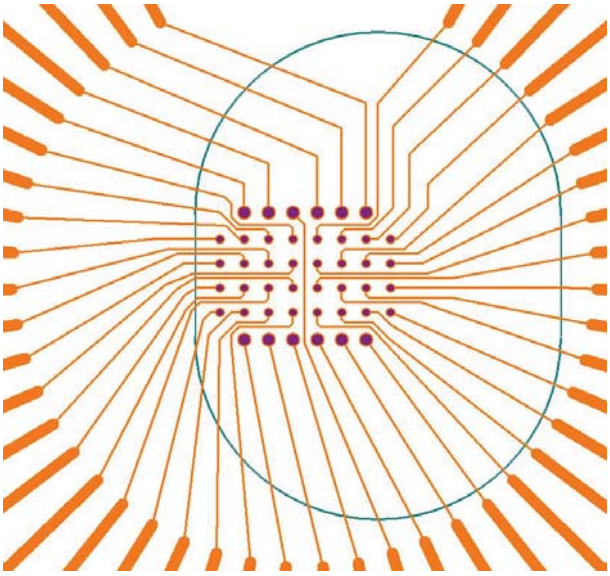
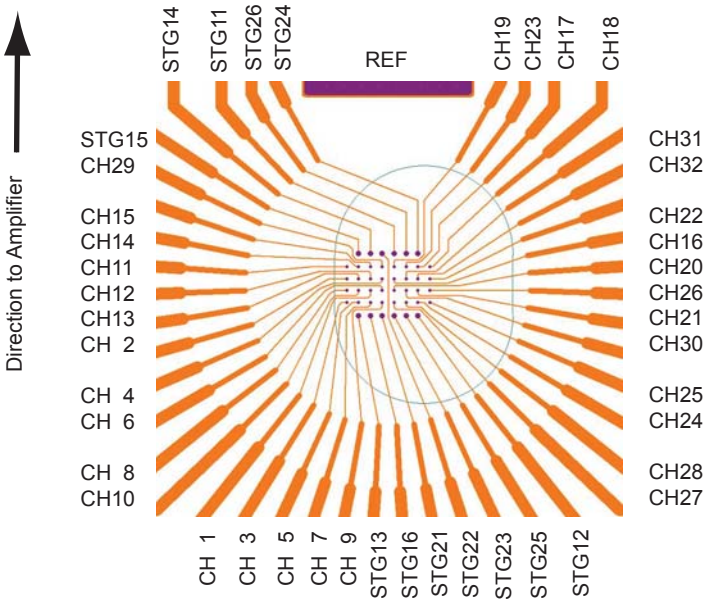
pMEA32S12 Layout 4

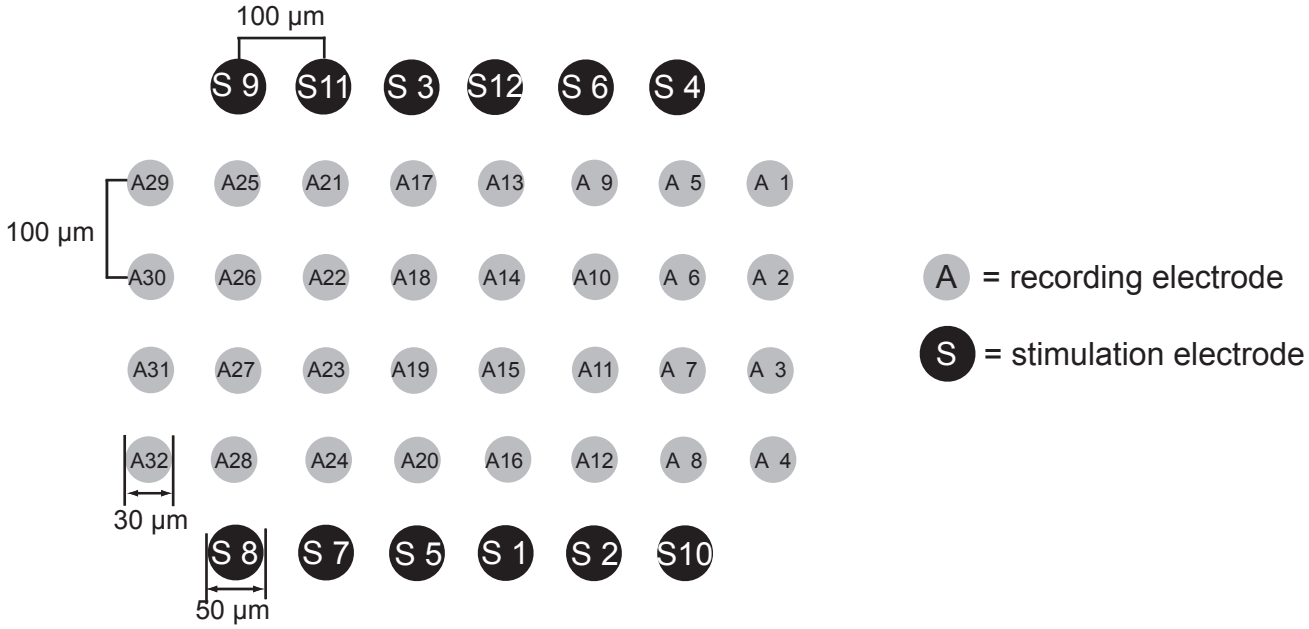
Perforated MEA for use with MEA2100-32- and USB-MEA32-STIM4-System



The oval area of the pMEA chip is perforated



Electrode layout in the grid



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pMEA32S12 Layout 4

Perforated MEA for use with MEA2100-32- and USB-MEA32-STIM4-System

MC_Rack channel map: pMEA-32S12-L4_8x4.cmp

11	14	15	29	19	23	17	18
2	13	12	4	16	31	32	22
8	10	1	6	20	30	21	26
3	5	7	9	27	28	24	25

The MC_Rack channel map is build analog to the layout of the recording electrode in the grid.

A29	A25	A21	A17	A13	A 9	A 5	A 1
A30	A26	A22	A18	A14	A10	A 6	A 2
A 31	A27	A23	A19	A15	A11	A 7	A 3
A32	A28	A24	A20	A16	A12	A 8	A 4

Table:
Correlation of MC_Rack channels and recording electrodes

A = Number of recording electrode, CH = Channel number in MC_Rack
S = Number of stimulation electrode, STG = Internal stimulus generator connection
REF = Reference electrode

S 1	STG 23	REF	STG 16	S 7
S 2	STG 25		STG 13	S 8
S 3	STG 22		STG 15	S 9
S 4	STG 24		STG 12	S 10
S 5	STG 21		STG 14	S 11
S 6	STG 26		STG 11	S 12

A 19	CH 6	CH 30	A 11
A 20	CH 9	CH 31	A 10
A 31	CH 8	CH 29	A 17
A 21	CH 15	CH 28	A 12
A 24	CH 7	CH 19	A 13
A 27	CH 10	CH 17	A 5
A 25	CH 14	CH 27	A 16
A 28	CH 5	CH 26	A 3
A 18	CH 4	CH 18	A 1
A 29	CH 11	CH 24	A 8
A 32	CH 3	CH 23	A 9
A 26	CH 13	CH 21	A 7
A 22	CH 12	CH 32	A 6
A 23	CH 1	CH 22	A 2
A 30	CH 2	CH 20	A 15
A 14	CH 16	CH 25	A 4

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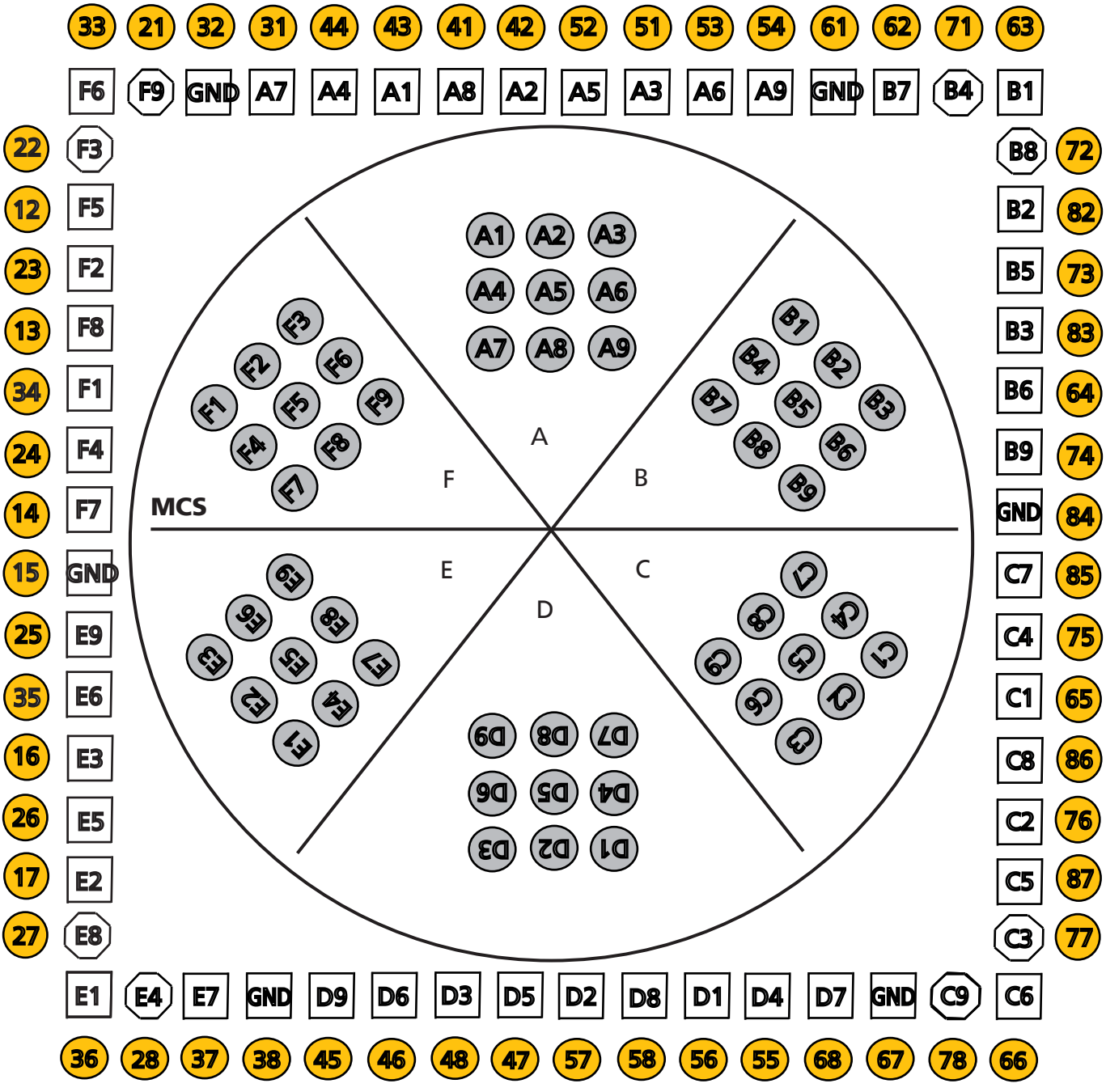
60-6wellMEA

Electrode Layout

A1 The letter-digit code is the electrode identifier and refers to the position of the electrode in the 60-6wellMEA.

33 The specified amplifier pin numbers are the MEA-System channel numbers that are used in MC_Rack program. The pin numbers 32, 61, 84, 67, 38, and 15 are grounded.



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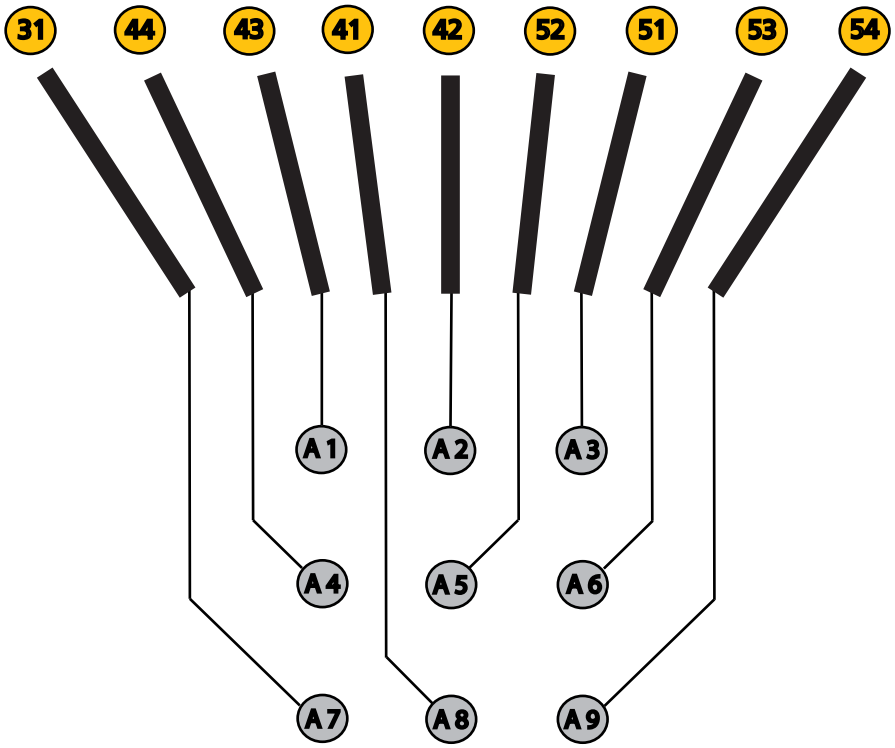
60-6wellMEA

Electrode layout inside each well Example: Well A



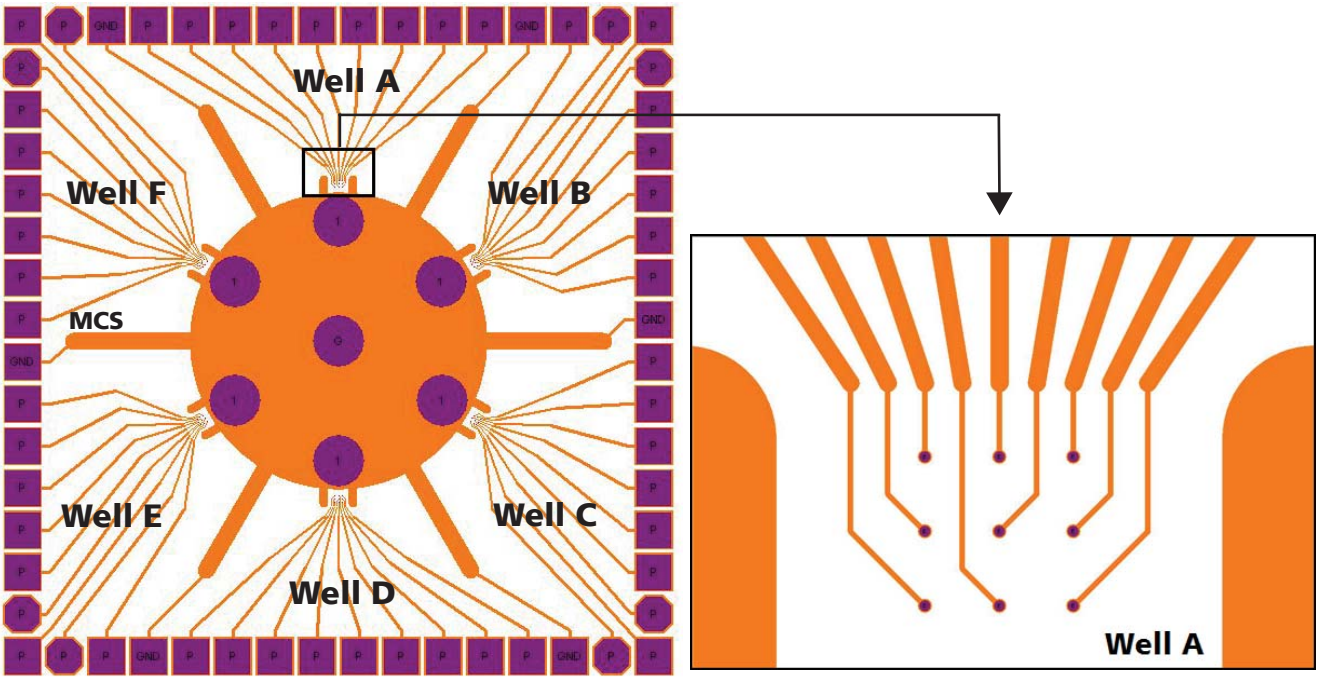
MEA amplifier pin numbers

Electrode identifier code refering to the position in the 60-6wellMEA.

Overwiev:
MEA amplifier pin numbers (digit) and correspondent electrode identifier code (letter-digit) inside each well.

	A	B	C	D	E	F
1	43	63	65	56	36	34
2	42	82	76	57	17	23
3	51	83	77	48	16	22
4	44	71	75	55	28	24
5	52	73	87	47	26	12
6	53	64	66	46	35	33
7	31	62	85	68	37	14
8	41	72	86	58	27	13
9	54	74	78	45	25	21
GND	32	61	84	67	38	15

Important: Please insert the 60-6wellMEA into the MEA amplifier with the writing on the MEA chip (in this example MCS) on the left side viewed from the front, with the sockets of the MEA1060 amplifier or the articulation of the MEA2100 headstage in the back.



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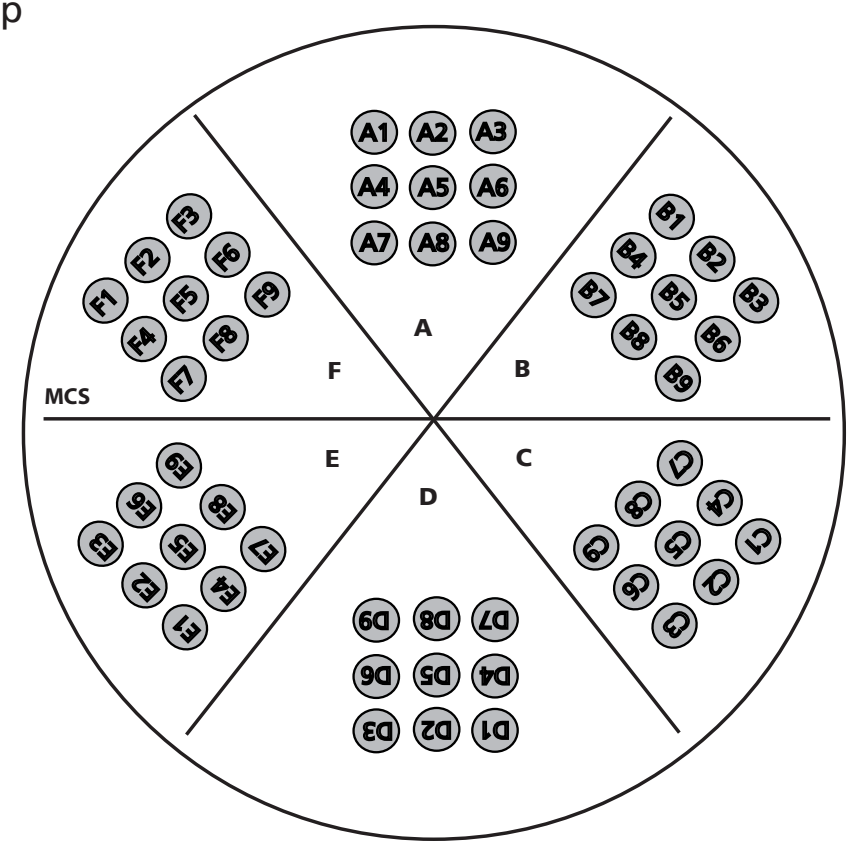
60-6wellMEA

MC_Rack Electrode Layout
Channel Map


A1 A2 A3
A4 A5 A6
A7 A8 A9
A
B
C
D
E
F
MCS
F1 F2 F3 F4 F5 F6 F7 F8 F9
B1 B2 B3 B4 B5 B6 B7 B8 B9
C1 C2 C3 C4 C5 C6 C7 C8 C9
D1 D2 D3 D4 D5 D6 D7 D8 D9
E1 E2 E3 E4 E5 E6 E7 E8 E9

Please make sure to select in MC_Rack program “Data Source Setup”, “Source layout” 2 dim. (MEA) (= digit code) or Configuration (= letter digit code).

F1	F2	F3	A1	A2	A3	B1	B2	B3	The letter-digit code is the electrode identifier and refers to the position of the electrode in the 60-6wellMEA.
34	23	22	43	42	51	63	82	83	
F4	F5	F6	A4	A5	A6	B4	B5	B6	
24	12	33	44	52	53	71	73	64	
F7	F8	F9	A7	A8	A9	B7	B8	B9	The amplifier electrode numbers (digit) are in same sequence as they are in the data display of MC_Rack.
14	13	21	31	41	54	62	72	74	
E9	E8	E7	D9	D8	D7	C9	C8	C7	
25	27	37	45	58	68	78	86	85	
E6	E5	E4	D6	D5	D4	C6	C5	C4	
35	26	28	46	47	55	66	87	75	Channel map:
E3	E2	E1	D3	D2	D1	C3	C2	C1	6-Well-MEA.cmp
16	17	36	48	57	56	77	76	65	

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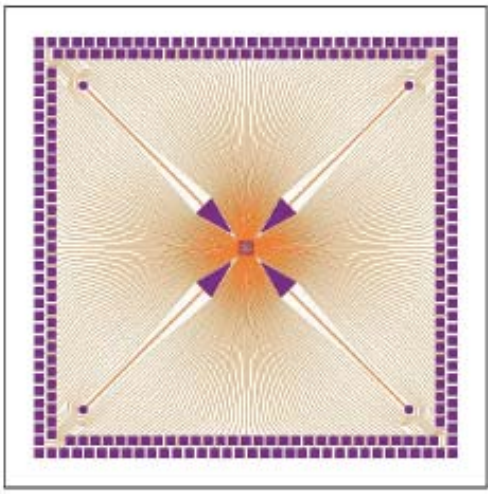
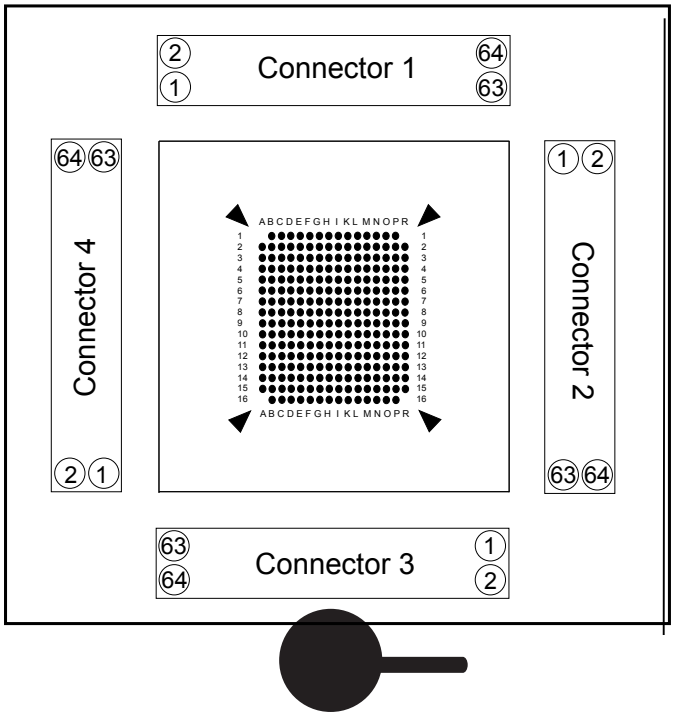
256MEA

256MEA30/8iR-ITO
256MEA60/10iR-ITO
256MEA100/30iR-ITO
256MEA200/30iR-ITO



256 Microelectrode Array for use with USB-MEA256-System.



Technical Specifications 256MEA

Temperature compatibility	0 - 125 °C
Dimension (W x D x H)	49 mm x 49 mm x 1 mm
Base material	Glass
Contact pads and track material	Indium tin oxide (ITO)
Electrode diameter	8, 10 or 30 µm
Interelectrode distance (centre to centre)	30, 60, 100 or 200 µm
Electrode height	Planar
Electrode type	Titanium nitride (TiN)
Isolation type	Silicon nitride (SiN)
Electrode impedance	30 - 50 kΩ for 30 µm, or 250 - 400 kΩ for 10 µm
Electrode layout grid	16 x 16
Number of recording electrodes	252
Number of reference electrodes	4 internal reference electrodes (iR)
Contact pads for reference electrodes (connected to ground)	4
MC_Rack	
Source layout in “Data Source Setup”	Configuration
Channel map	16 x 16.cmp

MEA perfusion chamber	(w/o)	Without ring
	(gr)	Glass ring: ID +/- 19 mm, OD 24 mm, height 6 / 12 mm
	(pr)	Plastic ring without thread: ID 26.5 mm, OD 30 mm, height 6 / 3 mm
	(pr-T)	Plastic ring with thread: ID 26 mm, OD 30 mm, height 6 / 15 mm

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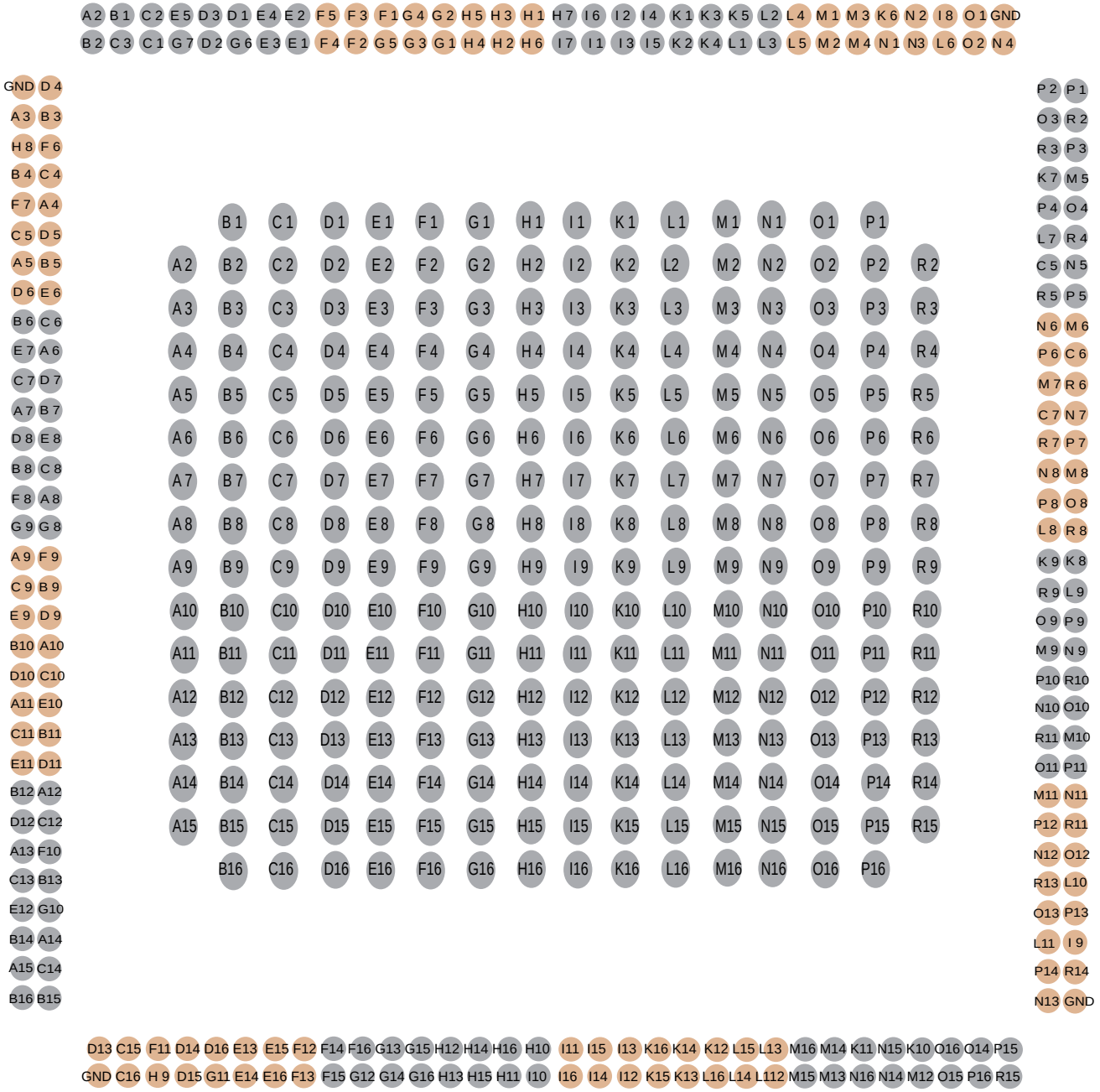
256MEA



The letter digit code is the electrode identifier, and refers to the position of the electrode in the 16 x 16 layout grid.
The layout of the letter digit code for the four connectors of the USB-MEA256 amplifier is shown.
To correlate the pin layout of the connectors, please see the table on the next page.

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256MEA

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Stimulation Connector Socket 1				Stimulation Connector Socket 2				Stimulation Connector Socket 3				Stimulation Connector Socket 4			
Electrode ID	Stim. Socket	Spring Contact	Hardware ID	Electrode ID	Stim. Socket	Spring Contact	Hardware ID	Electrode ID	Stim. Socket	Spring Contact	Hardware ID	Electrode ID	Stim. Socket	Spring Contact	Hardware ID
A2	2	1	196	I 9	60	191	125	C15	61	98	239	A10	25	113	236
B1	4	133	130	K7	7	38	41	C16	62	222	209	A11	22	232	205
B2	1	2	226	K8	34	178	74	D13	63	99	171	A12	15	108	169
C1	5	4	223	K9	33	51	104	D14	57	96	184	A13	12	227	143
C2	6	134	193	L10	56	189	2	D15	58	220	213	A14	5	103	241
C3	3	3	158	L11	59	64	30	D16	55	95	181	A15	4	223	141
D1	12	137	254	L7	11	40	42	E13	53	94	182	A3	62	252	195
D2	9	6	224	L8	31	50	35	E14	54	218	243	A4	55	128	159
D3	10	136	194	L9	36	179	5	E15	51	93	179	A5	52	247	131
E1	15	9	55	M10	46	184	69	E16	52	217	147	A6	45	123	229
E2	16	139	25	M11	49	59	100	F11	59	97	183	A7	42	242	202
E3	13	8	123	M5	8	165	14	F12	49	92	180	A8	35	118	166
E4	14	138	93	M6	18	170	78	F13	50	216	145	A9	32	237	138
E5	8	135	253	M7	21	45	105	F14	47	91	177	B10	26	234	206
F1	22	142	91	M8	28	175	7	F15	48	215	191	B11	19	110	170
F2	19	11	56	M9	39	54	33	F16	45	90	178	B12	16	229	144
F3	20	141	26	N10	43	56	34	G11	56	219	245	B13	9	105	242
F4	17	10	124	N11	50	186	70	G12	46	214	192	B14	6	224	211
F5	18	140	94	N12	53	61	97	G13	43	89	175	B15	1	101	240
G1	25	14	122	N13	63	66	27	G14	44	213	189	B16	2	100	210
G2	26	144	92	N5	14	168	77	G15	41	88	176	B3	61	131	225
G3	23	13	53	N6	17	43	108	G16	42	212	190	B4	58	250	198
G4	24	143	23	N7	24	173	10	H10	33	84	150	B5	51	126	162
G5	21	12	121	N8	27	48	38	H11	36	209	185	B6	48	245	134
G6	11	7	156	N9	40	181	6	H12	39	87	153	B7	41	121	232
G7	7	5	155	O10	44	183	3	H13	40	211	187	B8	38	240	201
H1	32	147	21	O11	47	58	31	H14	37	86	152	B9	29	115	233
H2	29	16	119	O12	54	188	67	H15	38	210	188	C10	23	112	167
H3	30	146	89	O13	57	63	98	H16	35	85	154	C11	20	231	139
H4	27	15	54	O3	3	36	44	H9	60	221	215	C12	13	107	237
H5	28	145	24	O4	10	166	80	I 10	34	208	186	C13	10	226	212
H6	31	17	51	O5	13	41	107	I 11	31	83	151	C14	3	102	172
H7	34	148	90	O6	20	171	9	I 12	28	205	59	C4	57	129	228
I 1	35	19	52	O7	23	46	37	I 13	27	81	149	C5	54	248	197
I 2	38	150	87	O8	30	176	73	I 14	30	206	62	C6	47	124	161
I 3	37	20	117	O9	37	53	101	I 15	29	82	148	C7	44	243	133
I 4	40	151	19	P1	2	34	82	I 16	32	207	61	C8	37	119	231
I 5	39	21	49	P10	41	55	102	K10	7	71	63	C9	30	236	203
I 6	36	149	22	P11	48	185	4	K11	11	73	247	D10	24	233	140
I 7	33	18	120	P12	51	60	32	K12	21	78	250	D11	17	109	238
I 8	60	161	16	P13	58	190	68	K13	24	203	57	D12	14	228	207
K1	42	152	88	P14	61	65	95	K14	23	79	251	D4	63	132	157
K2	41	22	118	P2	1	35	112	K15	26	204	60	D5	53	127	227
K3	44	153	20	P3	6	164	79	K16	25	80	146	D6	50	246	200
K4	43	23	50	P4	9	39	110	L12	18	200	220	D7	43	122	164
K5	46	154	85	P5	16	169	12	L13	17	76	248	D8	40	241	136
K6	56	159	15	P6	19	44	40	L14	20	201	221	D9	27	114	168
L1	45	24	115	P7	26	174	76	L15	19	77	252	E10	21	111	235
L2	48	155	17	P8	29	49	103	L16	22	202	58	E11	18	230	208
L3	47	25	47	P9	38	180	71	M12	8	195	217	E12	8	225	142
L4	50	156	86	R10	42	182	72	M13	14	198	218	E6	49	125	230
L5	49	26	116	R11	45	57	99	M14	13	74	246	E7	46	244	199
L6	59	31	46	R12	52	187	1	M15	16	199	222	E8	39	120	163
M1	52	157	18	R13	55	62	29	M16	15	75	249	E9	28	235	137
M2	51	27	48	R14	62	192	65	N14	10	196	216	F10	11	106	174
M3	54	158	83	R2	4	163	13	N15	9	72	244	F6	59	130	160
M4	53	28	113	R3	5	37	109	N16	12	197	219	F7	56	249	132
N1	55	29	45	R4	12	167	11	O14	3	69	28	F8	36	239	135
N2	58	160	84	R5	15	42	39	O15	6	194	214	F9	31	116	165
N3	57	30	114	R6	22	172	75	O16	5	70	64	G10	7	104	173
N4	63	33	43	R7	25	47	106	P15	1	68	96	G8	33	117	234
O1	62	162	81	R8	32	177	8	P16	4	193	126	G9	34	238	204
O2	61	32	111	R9	35	52	36	R15	2	67	66	H8	60	251	129
GND	64	253		GND	64	254		GND	64	255		GND	64	256	

Stim. Socket = Stimulation socket number in the connectors 1 to 4
Spring Contact = Spring contacts in the lid of the amplifier
Hardware ID = Hardware channel ID of MC_Rack hardware channels, using the linear layout
Electrode ID = Electrode ID of the MEA electrode in the 16 x 16 layout grid

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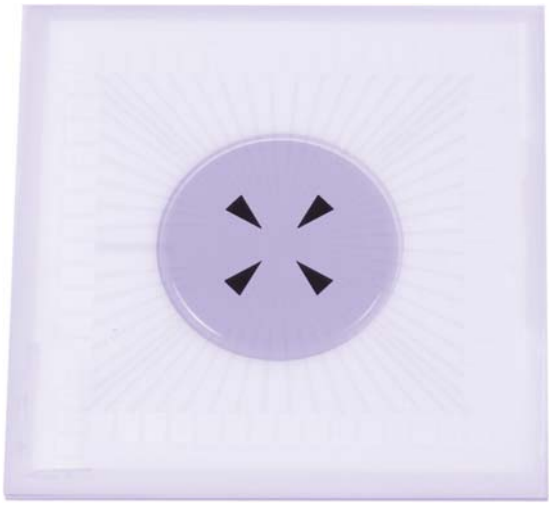
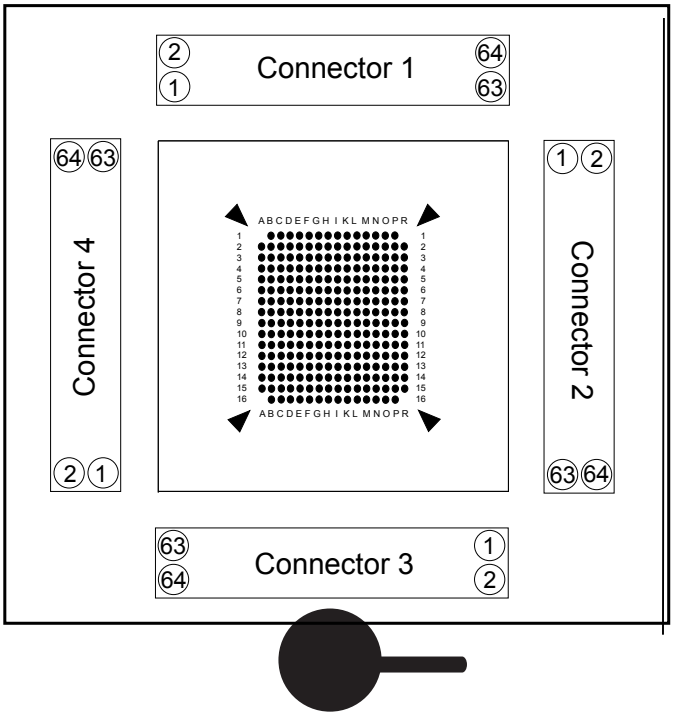
256ThinMEA

256ThinMEA200/30iR-ITO





Thin microelectrode array with 16 x 16 layout. The electrodes are embedded in a very thin glass substrate on a robust ceramic carrier. Contact pads and tracks are made from transparent ITO for high resolution imaging.

Technical Specifications 256ThinMEA200/30iR-ITO

Temperature compatibility	0 - 125 °C
Dimension (W x D x H)	49 mm x 49 mm x 1 mm
Thickness of the glass part	180 µm
Base material	Glass on ceramic carrier
Contact pads and track material	Indium tin oxide (ITO)
Electrode diameter	30 µm
Interelectrode distance (centre to centre)	200 µm
Electrode height	Planar
Electrode type	Titanium nitride (TiN)
Isolation type	Silicon nitride (SiN)
Electrode impedance	30 - 50 kΩ
Electrode layout grid	16 x 16
Number of recording electrodes	252
Number of reference electrodes	4 internal reference electrodes (iR)
Contact pads for reference electrodes (connected to ground)	4
MC_Rack	
Source layout in “Data Source Setup”	Configuration
Channel map	16 x 16.cmp

MEA perfusion chamber	(w/o)	Without ring
	(gr)	Glass ring: ID +/- 19 mm, OD 24 mm, height 6 / 12 mm
	(pr)	Plastic ring without thread: ID 26.5 mm, OD 30 mm, height 6 / 3 mm
	(pr-T)	Plastic ring with thread: ID 26 mm, OD 30 mm, height 6 / 15 mm

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256ThinMEA

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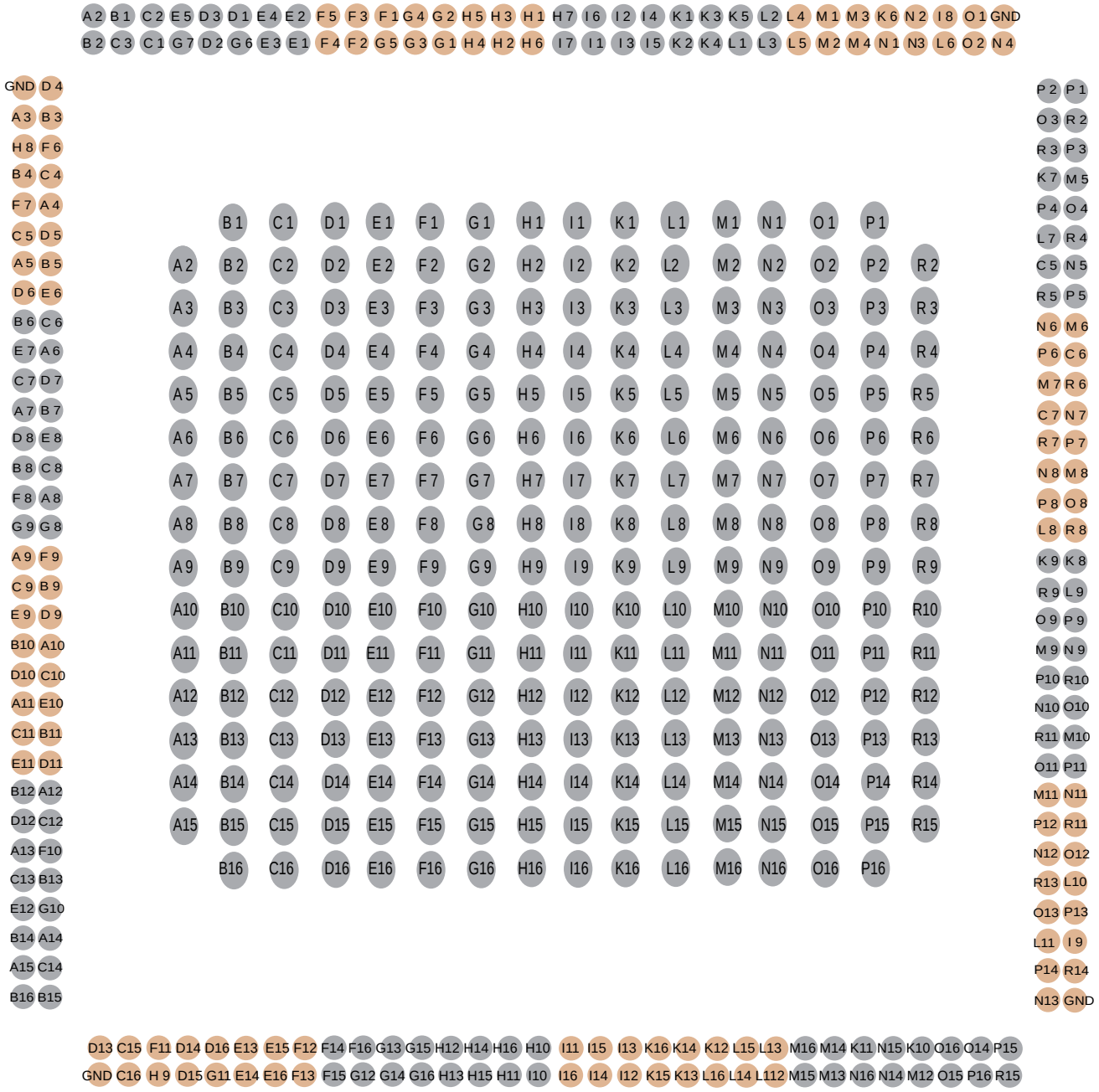

The letter digit code is the electrode identifier, and refers to the position of the electrode in the 16 x 16 layout grid. The layout of the letter digit code for the four connectors of the USB-MEA256 amplifier is shown.

To correlate the pin layout of the connectors, please see the table on the next page.

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256ThinMEA

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Stimulation Connector Socket 1			
Electrode ID	Stim. Socket	Spring Contact	Hardware ID
A2	2	1	196
B1	4	133	130
B2	1	2	226
C1	5	4	223
C2	6	134	193
C3	3	3	158
D1	12	137	254
D2	9	6	224
D3	10	136	194
E1	15	9	55
E2	16	139	25
E3	13	8	123
E4	14	138	93
E5	8	135	253
F1	22	142	91
F2	19	11	56
F3	20	141	26
F4	17	10	124
F5	18	140	94
G1	25	14	122
G2	26	144	92
G3	23	13	53
G4	24	143	23
G5	21	12	121
G6	11	7	156
G7	7	5	155
H1	32	147	21
H2	29	16	119
H3	30	146	89
H4	27	15	54
H5	28	145	24
H6	31	17	51
H7	34	148	90
I 1	35	19	52
I 2	38	150	87
I 3	37	20	117
I 4	40	151	19
I 5	39	21	49
I 6	36	149	22
I 7	33	18	120
I 8	60	161	16
K1	42	152	88
K2	41	22	118
K3	44	153	20
K4	43	23	50
K5	46	154	85
K6	56	159	15
L1	45	24	115
L2	48	155	17
L3	47	25	47
L4	50	156	86
L5	49	26	116
L6	59	31	46
M1	52	157	18
M2	51	27	48
M3	54	158	83
M4	53	28	113
N1	55	29	45
N2	58	160	84
N3	57	30	114
N4	63	33	43
O1	62	162	81
O2	61	32	111
GND	64	253	

Stimulation Connector Socket 2			
Electrode ID	Stim. Socket	Spring Contact	Hardware ID
I 9	60	191	125
K7	7	38	41
K8	34	178	74
K9	33	51	104
L10	56	189	2
L11	59	64	30
L7	11	40	42
L8	31	50	35
L9	36	179	5
M10	46	184	69
M11	49	59	100
M5	8	165	14
M6	18	170	78
M7	21	45	105
M8	28	175	7
M9	39	54	33
N10	43	56	34
N11	50	186	70
N12	53	61	97
N13	63	66	27
N5	14	168	77
N6	17	43	108
N7	24	173	10
N8	27	48	38
N9	40	181	6
O10	44	183	3
O11	47	58	31
O12	54	188	67
O13	57	63	98
O3	3	36	44
O4	10	166	80
O5	13	41	107
O6	20	171	9
O7	23	46	37
O8	30	176	73
O9	37	53	101
P1	2	34	82
P10	41	55	102
P11	48	185	4
P12	51	60	32
P13	58	190	68
P14	61	65	95
P2	1	35	112
P3	6	164	79
P4	9	39	110
P5	16	169	12
P6	19	44	40
P7	26	174	76
P8	29	49	103
P9	38	180	71
R10	42	182	72
R11	45	57	99
R12	52	187	1
R13	55	62	29
R14	62	192	65
R2	4	163	13
R3	5	37	109
R4	12	167	11
R5	15	42	39
R6	22	172	75
R7	25	47	106
R8	32	177	8
R9	35	52	36
GND	64	254	

Stimulation Connector Socket 3			
Electrode ID	Stim. Socket	Spring Contact	Hardware ID
C15	61	98	239
C16	62	222	209
D13	63	99	171
D14	57	96	184
D15	58	220	213
D16	55	95	181
E13	53	94	182
E14	54	218	243
E15	51	93	179
E16	52	217	147
F11	59	97	183
F12	49	92	180
F13	50	216	145
F14	47	91	177
F15	48	215	191
F16	45	90	178
G11	56	219	245
G12	46	214	192
G13	43	89	175
G14	44	213	189
G15	41	88	176
G16	42	212	190
H10	33	84	150
H11	36	209	185
H12	39	87	153
H13	40	211	187
H14	37	86	152
H15	38	210	188
H16	35	85	154
H9	60	221	215
I 10	34	208	186
I 11	31	83	151
I 12	28	205	59
I 13	27	81	149
I 14	30	206	62
I 15	29	82	148
I 16	32	207	61
K10	7	71	63
K11	11	73	247
K12	21	78	250
K13	24	203	57
K14	23	79	251
K15	26	204	60
K16	25	80	146
L12	18	200	220
L13	17	76	248
L14	20	201	221
L15	19	77	252
L16	22	202	58
M12	8	195	217
M13	14	198	218
M14	13	74	246
M15	16	199	222
M16	15	75	249
N14	10	196	216
N15	9	72	244
N16	12	197	219
O14	3	69	28
O15	6	194	214
O16	5	70	64
P15	1	68	96
P16	4	193	126
R15	2	67	66
GND	64	255	

Stimulation Connector Socket 4			
Electrode ID	Stim. Socket	Spring Contact	Hardware ID
A10	25	113	236
A11	22	232	205
A12	15	108	169
A13	12	227	143
A14	5	103	241
A15	4	223	141
A3	62	252	195
A4	55	128	159
A5	52	247	131
A6	45	123	229
A7	42	242	202
A8	35	118	166
A9	32	237	138
B10	26	234	206
B11	19	110	170
B12	16	229	144
B13	9	105	242
B14	6	224	211
B15	1	101	240
B16	2	100	210
B3	61	131	225
B4	58	250	198
B5	51	126	162
B6	48	245	134
B7	41	121	232
B8	38	240	201
B9	29	115	233
C10	23	112	167
C11	20	231	139
C12	13	107	237
C13	10	226	212
C14	3	102	172
C4	57	129	228
C5	54	248	197
C6	47	124	161
C7	44	243	133
C8	37	119	231
C9	30	236	203
D10	24	233	140
D11	17	109	238
D12	14	228	207
D4	63	132	157
D5	53	127	227
D6	50	246	200
D7	43	122	164
D8	40	241	136
D9	27	114	168
E10	21	111	235
E11	18	230	208
E12	8	225	142
E6	49	125	230
E7	46	244	199
E8	39	120	163
E9	28	235	137
F10	11	106	174
F6	59	130	160
F7	56	249	132
F8	36	239	135
F9	31	116	165
G10	7	104	173
G8	33	117	234
G9	34	238	204
H8	60	251	129
GND	64	256	

Stim. Socket = Stimulation socket number in the connectors 1 to 4
Spring Contact = Spring contacts in the lid of the amplifier
Hardware ID = Hardware channel ID of MC_Rack hardware channels, using the linear layout
Electrode ID = Electrode ID of the MEA electrode in the 16 x 16 layout grid

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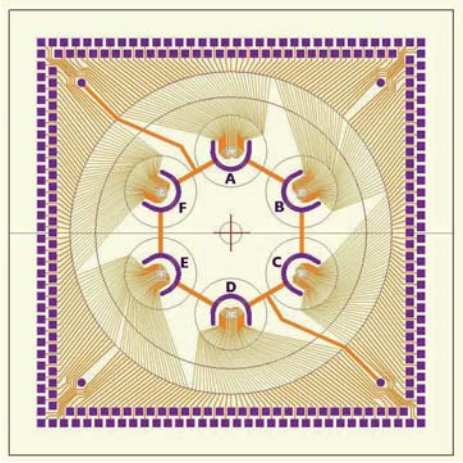
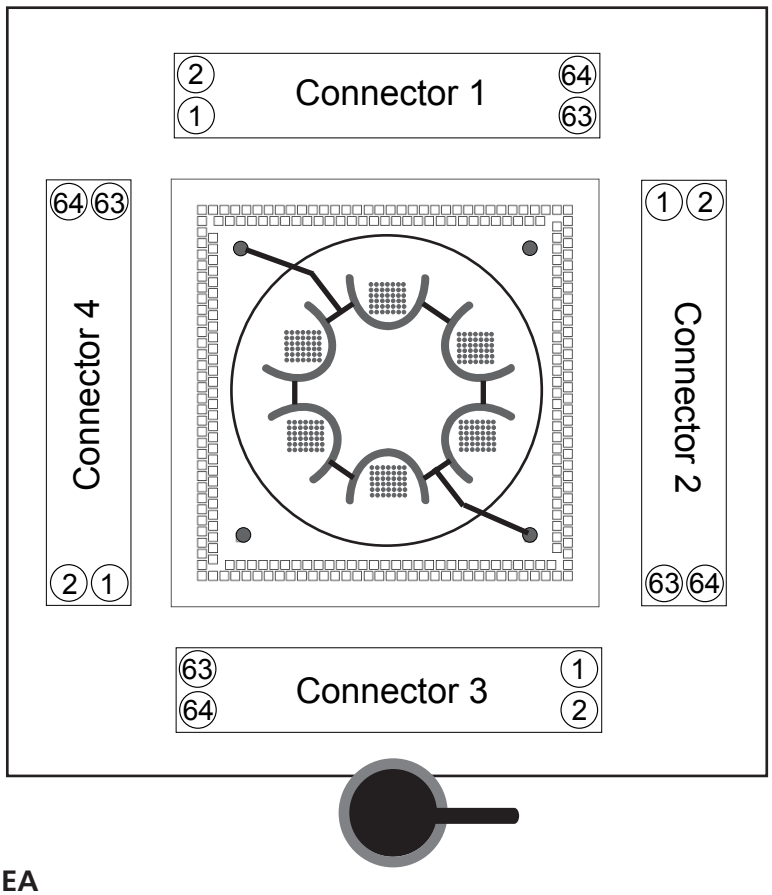
256-6wellMEA

256-6wellMEA200/30iR-ITO-rcr
256-6wellMEA200/30iR-ITO-tcr

6-Well Microelectrode Array for use with USB-MEA256-System.



The MEA is not symmetrical and has to be inserted into the amplifier with well A on top as shown in the picture.



Technical Specifications 256-6wellMEA

Temperature compatibility		0 - 125 °C
Dimension (W x D x H)		49 mm x 49 mm x 1 mm
Base material		Glass
Contact pads and track material		Titanium nitride (TiN) and Titanium (Ti)
Electrode diameter		30 µm
Interelectrode distance (centre to centre)		200 µm
Electrode height		Planar
Electrode type		Titanium nitride (TiN)
Isolation type		Silicon nitride (SiN)
Electrode impedance		30 - 50 kΩ
Electrode layout grid		6 x (7 x 6) electrodes
Number of recording electrodes		252 (42 recording electrodes in each well)
Number of reference electrodes		6, one internal reference electrode (iR) around each well
Contact pads for reference electrodes (connected to ground)		4, the reference electrodes are connected to 2 pads only
Source layout in "Data Source Setup"		Configuration
Channel map		256-6wellMEA.cmp
MEA perfusion chamber	(tcr)	Triangle chamber ring with 6 wells OD 30 mm, ID 27 mm, height 10 mm of each well. Volumetric capacity of each well: minimum 700 µl.
	(rcr)	Round chamber ring with 6 wells: OD 30 mm, ID of the wells 7 mm, height 10 mm of each well. Volumetric capacity of each well: minimum 500 µl.

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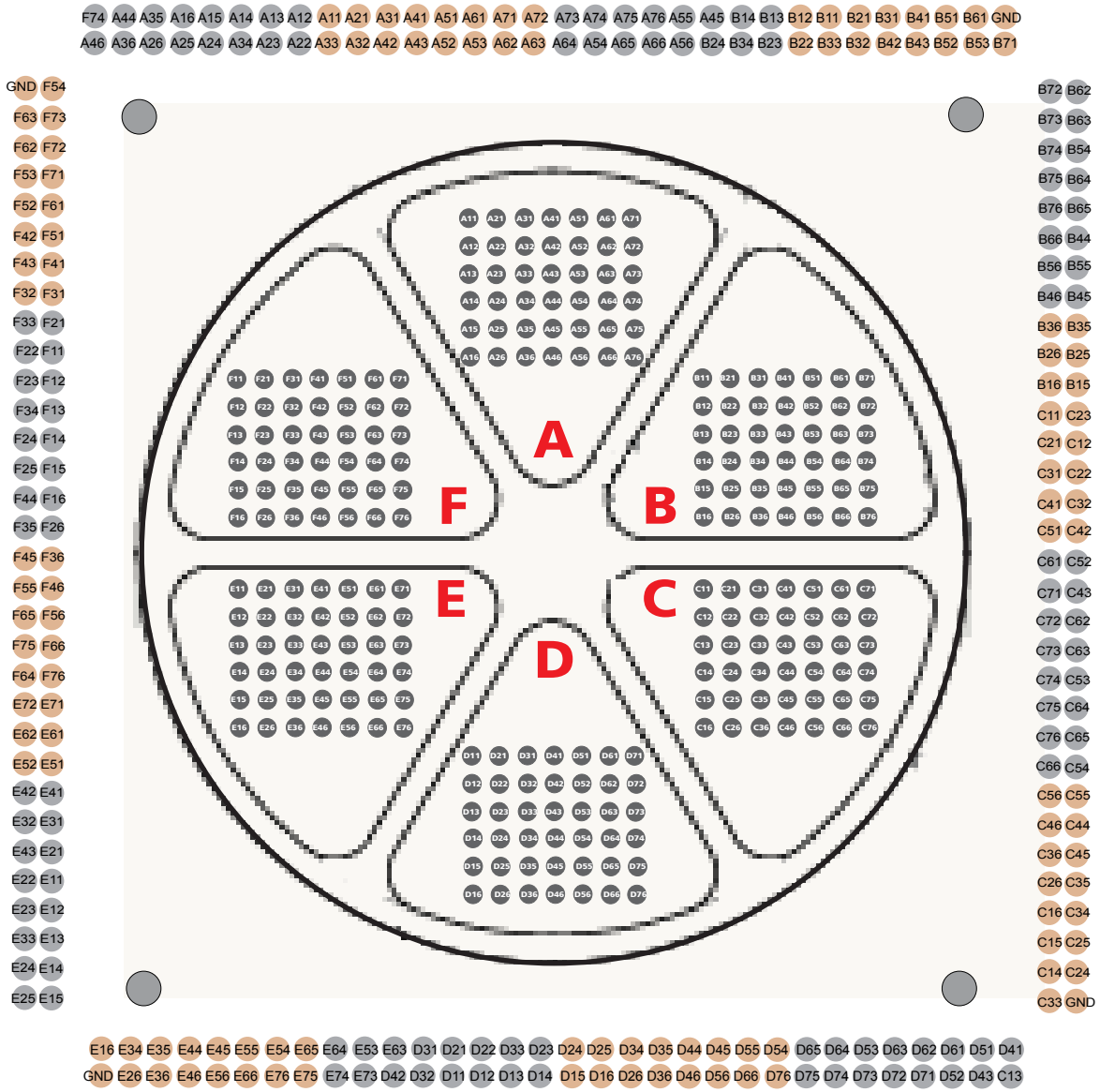
256-6wellMEA



Example Well A: The numbering of MEA electrodes in the 7 x 6 grid per each well follows the standard numbering scheme for square grids:

The first digit is the column number and the second digit is the row number. For example, electrode 23 is positioned in the second column of the third row.

There is one big internal reference electrode around each well. The six reference electrodes are connected to two of the four contact pads for grounding them.

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256-6wellMEA

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Connector 1				Connector 2				Connector 3				Connector 4			
Stim Socket	Electrode ID	Spring Con.	Hardware ID	Stim Socket	Electrode ID	Spring Con.	Hardware ID	Stim Socket	Electrode ID	Spring Con.	Hardware ID	Stim Socket	Electrode ID	Spring Con.	Hardware ID
1	A46	2	226	1	B72	35	112	1	D41	68	96	1	E15	101	240
2	F74	1	196	2	B62	34	82	2	C13	67	66	2	E25	100	210
3	A36	3	158	3	B73	36	44	3	D51	69	28	3	E14	102	172
4	A44	133	130	4	B63	163	13	4	D43	193	126	4	E24	223	141
5	A26	4	223	5	B74	37	109	5	D61	70	64	5	E13	103	241
6	A35	134	193	6	B54	164	79	6	D52	194	214	6	E33	224	211
7	A25	5	155	7	B75	38	41	7	D62	71	63	7	E12	104	173
8	A16	135	253	8	B64	165	14	8	D71	195	217	8	E23	225	142
9	A24	6	224	9	B76	39	110	9	D63	72	244	9	E11	105	242
10	A15	136	194	10	B65	166	80	10	D72	196	216	10	E22	226	212
11	A34	7	156	11	B66	40	42	11	D53	73	247	11	E21	106	174
12	A14	137	254	12	B44	167	11	12	D73	197	219	12	E43	227	143
13	A23	8	123	13	B56	41	107	13	D64	74	246	13	E31	107	237
14	A13	138	93	14	B55	168	77	14	D74	198	218	14	E32	228	207
15	A22	9	55	15	B46	42	39	15	D65	75	249	15	E41	108	169
16	A12	139	25	16	B45	169	12	16	D75	199	222	16	E42	229	144
17	A33	10	124	17	B36	43	108	17	D54	76	248	17	E51	109	238
18	A11	140	94	18	B35	170	78	18	D76	200	220	18	E52	230	208
19	A32	11	56	19	B26	44	40	19	D55	77	252	19	E61	110	170
20	A21	141	26	20	B25	171	9	20	D66	201	221	20	E62	231	139
21	A42	12	121	21	B16	45	105	21	D45	78	250	21	E71	111	235
22	A31	142	91	22	B15	172	75	22	D56	202	58	22	E72	232	205
23	A43	13	53	23	C11	46	37	23	D44	79	251	23	F76	112	167
24	A41	143	23	24	C23	173	10	24	D46	203	57	24	F64	233	140
25	A52	14	122	25	C21	47	106	25	D35	80	146	25	F66	113	236
26	A51	144	92	26	C12	174	76	26	D36	204	60	26	F75	234	206
27	A53	15	54	27	C31	48	38	27	D34	81	149	27	F56	114	168
28	A61	145	24	28	C22	175	7	28	D26	205	59	28	F65	235	137
29	A62	16	119	29	C41	49	103	29	D25	82	148	29	F46	115	233
30	A71	146	89	30	C32	176	73	30	D16	206	62	30	F55	236	203
31	A63	17	51	31	C51	50	35	31	D24	83	151	31	F36	116	165
32	A72	147	21	32	C42	177	8	32	D15	207	61	32	F45	237	138
33	A64	18	120	33	C61	51	104	33	D23	84	150	33	F26	117	234
34	A73	148	90	34	C52	178	74	34	D14	208	186	34	F35	238	204
35	A54	19	52	35	C71	52	36	35	D33	85	154	35	F16	118	166
36	A74	149	22	36	C43	179	5	36	D13	209	185	36	F44	239	135
37	A65	20	117	37	C72	53	101	37	D22	86	152	37	F15	119	231
38	A75	150	87	38	C62	180	71	38	D12	210	188	38	F25	240	201
39	A66	21	49	39	C73	54	33	39	D21	87	153	39	F14	120	163
40	A76	151	19	40	C63	181	6	40	D11	211	187	40	F24	241	136
41	A56	22	118	41	C74	55	102	41	D31	88	176	41	F13	121	232
42	A55	152	88	42	C53	182	72	42	D32	212	190	42	F34	242	202
43	B24	23	50	43	C75	56	34	43	E63	89	175	43	F12	122	164
44	A45	153	20	44	C64	183	3	44	D42	213	189	44	F23	243	133
45	B34	24	115	45	C76	57	99	45	E53	90	178	45	F11	123	229
46	B14	154	85	46	C65	184	69	46	E73	214	192	46	F22	244	199
47	B23	25	47	47	C66	58	31	47	E64	91	177	47	F21	124	161
48	B13	155	17	48	C54	185	4	48	E74	215	191	48	F33	245	134
49	B22	26	116	49	C56	59	100	49	E65	92	180	49	F31	125	230
50	B12	156	86	50	C55	186	70	50	E75	216	145	50	F32	246	200
51	B33	27	48	51	C46	60	32	51	E54	93	179	51	F41	126	162
52	B11	157	18	52	C44	187	1	52	E76	217	147	52	F43	247	131
53	B32	28	113	53	C36	61	97	53	E55	94	182	53	F51	127	227
54	B21	158	83	54	C45	188	67	54	E66	218	243	54	F42	248	197
55	B42	29	45	55	C26	62	29	55	E45	95	181	55	F61	128	159
56	B31	159	15	56	C35	189	2	56	E56	219	245	56	F52	249	132
57	B43	30	114	57	C16	63	98	57	E44	96	184	57	F71	129	228
58	B41	160	84	58	C34	190	68	58	E46	220	213	58	F53	250	198
59	B52	31	46	59	C15	64	30	59	E35	97	183	59	F72	130	160
60	B51	161	16	60	C25	191	125	60	E36	221	215	60	F62	251	129
61	B53	32	111	61	C14	65	95	61	E34	98	239	61	F73	131	225
62	B61	162	81	62	C24	192	65	62	E26	222	209	62	F63	252	195
63	B71	33	43	63	C33	66	27	63	E16	99	171	63	F54	132	157
GND				GND				GND				GND			

256-6wellMEA for use with USB-MEA256-System
Stim. Socket = Stimulation socket number in the connectors 1 to 4.
Spring Contact = Spring contacts in the lid of the amplifier, connecting to the contact pads of the 256-6wellMEA.
Hardware ID = Hardware channel ID of MC_Rack hardware channels, using the linear layout.
Electrode ID = Electrode ID of the MEA electrode in the 6 x (6 x 7) layout grid.

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256-6wellMEA

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Tables:

Electrode ID and number of stimulation connector socket in well A, B, and C.

Well A		Well B		Well C	
Electrode ID	Stimulation Socket	Electrode ID	Stimulation Socket	Electrode ID	Stimulation Socket
A46	Conn. 1 No. 1	B24	Conn. 1 No. 43	C11	Conn. 2 No. 23
F74	Conn. 1 No. 2	A45	Conn. 1 No. 44	C23	Conn. 2 No. 24
A36	Conn. 1 No. 3	B34	Conn. 1 No. 45	C21	Conn. 2 No. 25
A44	Conn. 1 No. 4	B14	Conn. 1 No. 46	C12	Conn. 2 No. 26
A26	Conn. 1 No. 5	B23	Conn. 1 No. 47	C31	Conn. 2 No. 27
A35	Conn. 1 No. 6	B13	Conn. 1 No. 48	C22	Conn. 2 No. 28
A25	Conn. 1 No. 7	B22	Conn. 1 No. 49	C41	Conn. 2 No. 29
A16	Conn. 1 No. 8	B12	Conn. 1 No. 50	C32	Conn. 2 No. 30
A24	Conn. 1 No. 9	B33	Conn. 1 No. 51	C51	Conn. 2 No. 31
A15	Conn. 1 No. 10	B11	Conn. 1 No. 52	C42	Conn. 2 No. 32
A34	Conn. 1 No. 11	B32	Conn. 1 No. 53	C61	Conn. 2 No. 33
A14	Conn. 1 No. 12	B21	Conn. 1 No. 54	C52	Conn. 2 No. 34
A23	Conn. 1 No. 13	B42	Conn. 1 No. 55	C71	Conn. 2 No. 35
A13	Conn. 1 No. 14	B31	Conn. 1 No. 56	C43	Conn. 2 No. 36
A22	Conn. 1 No. 15	B43	Conn. 1 No. 57	C72	Conn. 2 No. 37
A12	Conn. 1 No. 16	B41	Conn. 1 No. 58	C62	Conn. 2 No. 38
A33	Conn. 1 No. 17	B52	Conn. 1 No. 59	C73	Conn. 2 No. 39
A11	Conn. 1 No. 18	B51	Conn. 1 No. 60	C63	Conn. 2 No. 40
A32	Conn. 1 No. 19	B53	Conn. 1 No. 61	C74	Conn. 2 No. 41
A21	Conn. 1 No. 20	B61	Conn. 1 No. 62	C53	Conn. 2 No. 42
A42	Conn. 1 No. 21	B63	Conn. 1 No. 63	C75	Conn. 2 No. 43
A31	Conn. 1 No. 22	B72	Conn. 2 No. 1	C64	Conn. 2 No. 44
A43	Conn. 1 No. 23	B62	Conn. 2 No. 2	C76	Conn. 2 No. 45
A41	Conn. 1 No. 24	B73	Conn. 2 No. 3	C65	Conn. 2 No. 46
A52	Conn. 1 No. 25	B63	Conn. 2 No. 4	C66	Conn. 2 No. 47
A51	Conn. 1 No. 26	B74	Conn. 2 No. 5	C54	Conn. 2 No. 48
A53	Conn. 1 No. 27	B54	Conn. 2 No. 6	C56	Conn. 2 No. 49
A61	Conn. 1 No. 28	B75	Conn. 2 No. 7	C55	Conn. 2 No. 50
A62	Conn. 1 No. 29	B64	Conn. 2 No. 8	C46	Conn. 2 No. 51
A71	Conn. 1 No. 30	B76	Conn. 2 No. 9	C44	Conn. 2 No. 52
A63	Conn. 1 No. 31	B65	Conn. 2 No. 10	C36	Conn. 2 No. 53
A72	Conn. 1 No. 32	B66	Conn. 2 No. 11	C45	Conn. 2 No. 54
A64	Conn. 1 No. 33	B44	Conn. 2 No. 12	C26	Conn. 2 No. 55
A73	Conn. 1 No. 34	B56	Conn. 2 No. 13	C35	Conn. 2 No. 56
A54	Conn. 1 No. 35	B55	Conn. 2 No. 14	C16	Conn. 2 No. 57
A74	Conn. 1 No. 36	B46	Conn. 2 No. 15	C34	Conn. 2 No. 58
A65	Conn. 1 No. 37	B45	Conn. 2 No. 16	C15	Conn. 2 No. 59
A75	Conn. 1 No. 38	B36	Conn. 2 No. 17	C25	Conn. 2 No. 60
A86	Conn. 1 No. 39	B35	Conn. 2 No. 18	C14	Conn. 2 No. 61
A76	Conn. 1 No. 40	B26	Conn. 2 No. 19	C24	Conn. 2 No. 62
A56	Conn. 1 No. 41	B25	Conn. 2 No. 20	C33	Conn. 2 No. 63
A55	Conn. 1 No. 42	B16	Conn. 2 No. 21	D41	Conn. 3 No. 1
B24	Conn. 1 No. 43	B15	Conn. 2 No. 22	C13	Conn. 3 No. 2
A45	Conn. 1 No. 44				

Electrode ID and number of stimulation connector socket in well D, E, and F.

Well D		Well E		Well F	
Electrode ID	Stimulation Socket	Electrode ID	Stimulation Socket	Electrode ID	Stimulation Socket
D41	Conn. 3 No. 1	E63	Conn. 3 No. 43	F76	Conn. 4 No. 23
C13	Conn. 3 No. 2	D42	Conn. 3 No. 44	F64	Conn. 4 No. 24
D51	Conn. 3 No. 3	E53	Conn. 3 No. 45	F66	Conn. 4 No. 25
D43	Conn. 3 No. 4	E73	Conn. 3 No. 46	F75	Conn. 4 No. 26
D61	Conn. 3 No. 5	E64	Conn. 3 No. 47	F56	Conn. 4 No. 27
D52	Conn. 3 No. 6	E74	Conn. 3 No. 48	F65	Conn. 4 No. 28
D62	Conn. 3 No. 7	E65	Conn. 3 No. 49	F46	Conn. 4 No. 29
D71	Conn. 3 No. 8	E75	Conn. 3 No. 50	F55	Conn. 4 No. 30
D63	Conn. 3 No. 9	E54	Conn. 3 No. 51	F36	Conn. 4 No. 31
D72	Conn. 3 No. 10	E76	Conn. 3 No. 52	F45	Conn. 4 No. 32
D53	Conn. 3 No. 11	E55	Conn. 3 No. 53	F26	Conn. 4 No. 33
D73	Conn. 3 No. 12	E66	Conn. 3 No. 54	F35	Conn. 4 No. 34
D64	Conn. 3 No. 13	E45	Conn. 3 No. 55	F16	Conn. 4 No. 35
D74	Conn. 3 No. 14	E56	Conn. 3 No. 56	F44	Conn. 4 No. 36
D65	Conn. 3 No. 15	E44	Conn. 3 No. 57	F15	Conn. 4 No. 37
D75	Conn. 3 No. 16	E46	Conn. 3 No. 58	F25	Conn. 4 No. 38
D54	Conn. 3 No. 17	E35	Conn. 3 No. 59	F14	Conn. 4 No. 39
D76	Conn. 3 No. 18	E36	Conn. 3 No. 60	F24	Conn. 4 No. 40
D55	Conn. 3 No. 19	E34	Conn. 3 No. 61	F13	Conn. 4 No. 41
D66	Conn. 3 No. 20	E26	Conn. 3 No. 62	F34	Conn. 4 No. 42
D45	Conn. 3 No. 21	E16	Conn. 3 No. 63	F12	Conn. 4 No. 43
D56	Conn. 4 No. 22	E15	Conn. 4 No. 1	F23	Conn. 4 No. 44
D44	Conn. 4 No. 23	E25	Conn. 4 No. 2	F11	Conn. 4 No. 45
D46	Conn. 4 No. 24	E14	Conn. 4 No. 3	F22	Conn. 4 No. 46
D35	Conn. 4 No. 25	E24	Conn. 4 No. 4	F21	Conn. 4 No. 47
D36	Conn. 4 No. 26	E13	Conn. 4 No. 5	F33	Conn. 4 No. 48
D34	Conn. 4 No. 27	E33	Conn. 4 No. 6	F31	Conn. 4 No. 49
D26	Conn. 4 No. 28	E12	Conn. 4 No. 7	F32	Conn. 4 No. 50
D25	Conn. 4 No. 29	E23	Conn. 4 No. 8	F41	Conn. 4 No. 51
D16	Conn. 4 No. 30	E11	Conn. 4 No. 9	F43	Conn. 4 No. 52
D24	Conn. 4 No. 31	E22	Conn. 4 No. 10	F51	Conn. 4 No. 53
D15	Conn. 4 No. 32	E21	Conn. 4 No. 11	F42	Conn. 4 No. 54
D23	Conn. 4 No. 33	E43	Conn. 4 No. 12	F61	Conn. 4 No. 55
D14	Conn. 4 No. 34	E31	Conn. 4 No. 13	F52	Conn. 4 No. 56
D33	Conn. 4 No. 35	E32	Conn. 4 No. 14	F71	Conn. 4 No. 57
D13	Conn. 4 No. 36	E41	Conn. 4 No. 15	F53	Conn. 4 No. 58
D22	Conn. 4 No. 37	E42	Conn. 4 No. 16	F72	Conn. 4 No. 59
D12	Conn. 4 No. 38	E51	Conn. 4 No. 17	F62	Conn. 4 No. 60
D21	Conn. 4 No. 39	E52	Conn. 4 No. 18	F73	Conn. 4 No. 61
D11	Conn. 4 No. 40	E61	Conn. 4 No. 19	F63	Conn. 4 No. 62
D31	Conn. 4 No. 41	E62	Conn. 4 No. 20	F54	Conn. 4 No. 63
D32	Conn. 4 No. 42	E71	Conn. 4 No. 21	A46	Conn. 1 No. 1
E63	Conn. 4 No. 43	E72	Conn. 4 No. 22	F74	Conn. 1 No. 2
D42	Conn. 4 No. 44				

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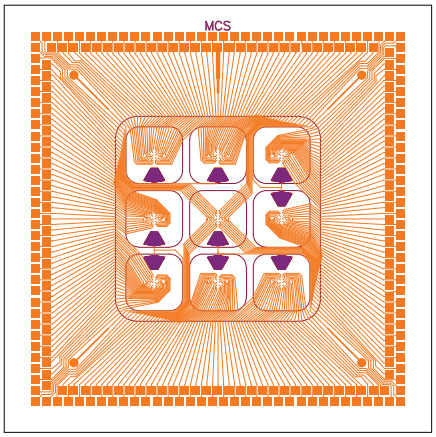
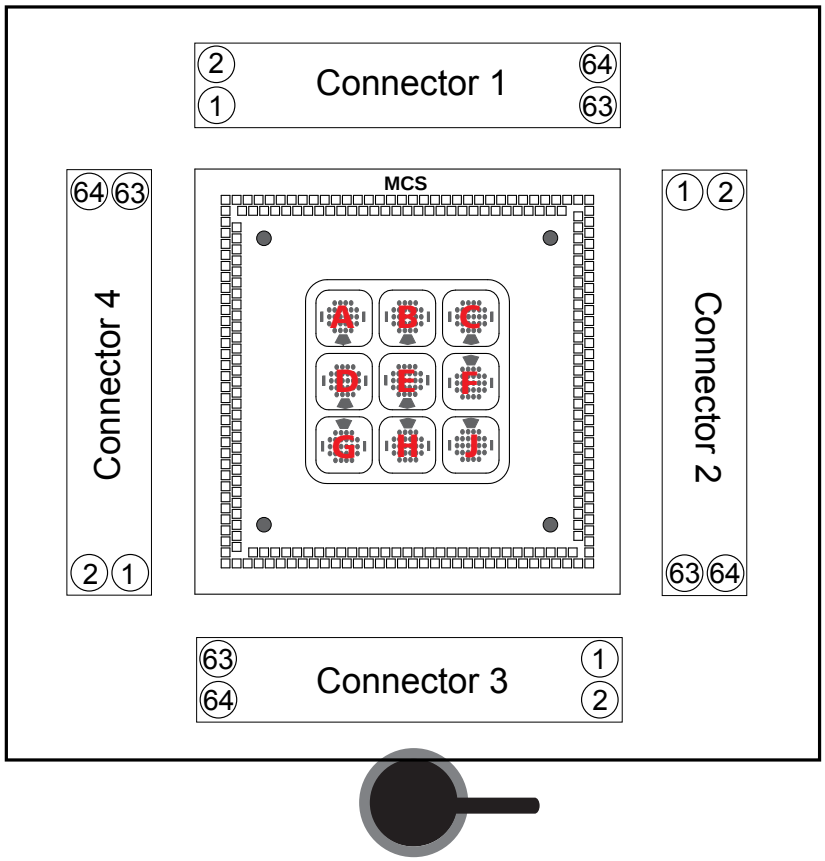
256-9wellMEA

256-9wellMEA300/30iR-ITO-w/o
256-9wellMEA300/30iR-ITO-mq

9-well Microelectrode Array for use with USB-MEA256-System.



The MEA is not symmetrical and has to be inserted into the amplifier with the writing MCS on top as shown in the picture beside.



Technical Specifications 9-Well MEA

Temperature compatibility	0 - 125 °C
Dimension (W x D x H)	49 mm x 49 mm x 1 mm
Base material	Glass
Contact pads and track material	Indium tin oxide (ITO)
Electrode diameter	30 µm (recording), 50 x 200 µm (stimulation)
Interelectrode distance (centre to centre)	300 µm (recording), 500 µm (stimulation)
Electrode height	Planar
Electrode type	Titanium nitride (TiN)
Isolation type	Silicon nitride (SiN)
Electrode impedance	30 - 50 kΩ
Electrode layout grid	6 x 5 recording + 2 stimulation electrodes in each well
Number of recording electrodes	252 (26 recording electrodes in each well)
Number of reference electrodes	9 (1 internal reference electrode (iR) in each well)
Contact pads for reference electrodes (connected to ground)	4
Source layout in “Data Source Setup”	Configuration
Channel map	9-well-256MEA.cmp

MEA perfusion chamber	(w/o)	Without Macrolon quadrat
	(mq)	Macrolon quadrat with 9 wells: ID 6.5 x 6.5 mm of each well, OD 24 x 24 mm of all wells, height 9 mm, Volumetric capacity of each well: minimum 250 µl.

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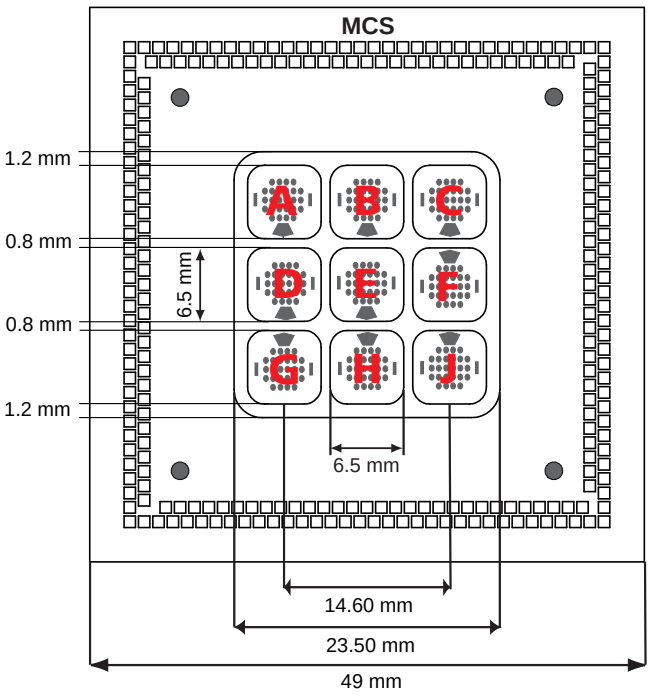
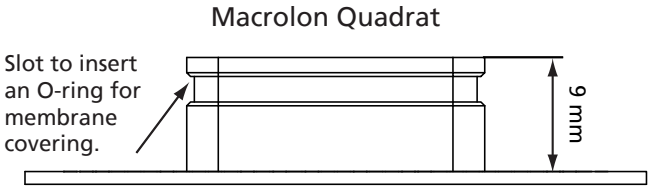
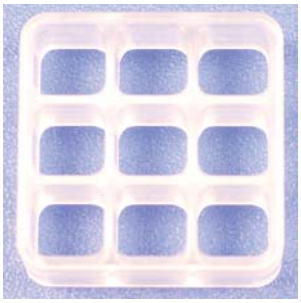
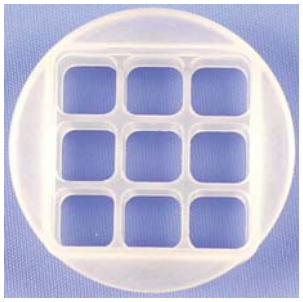




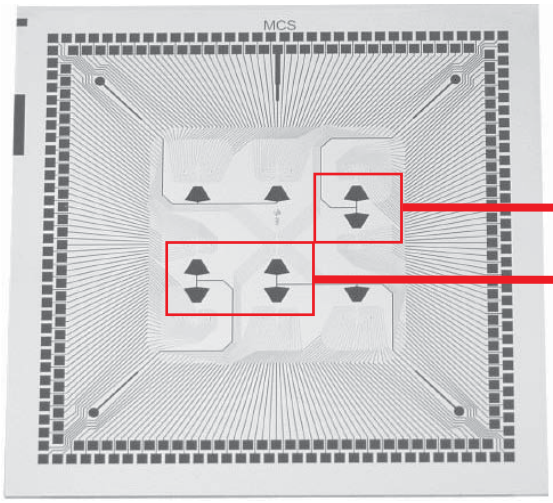


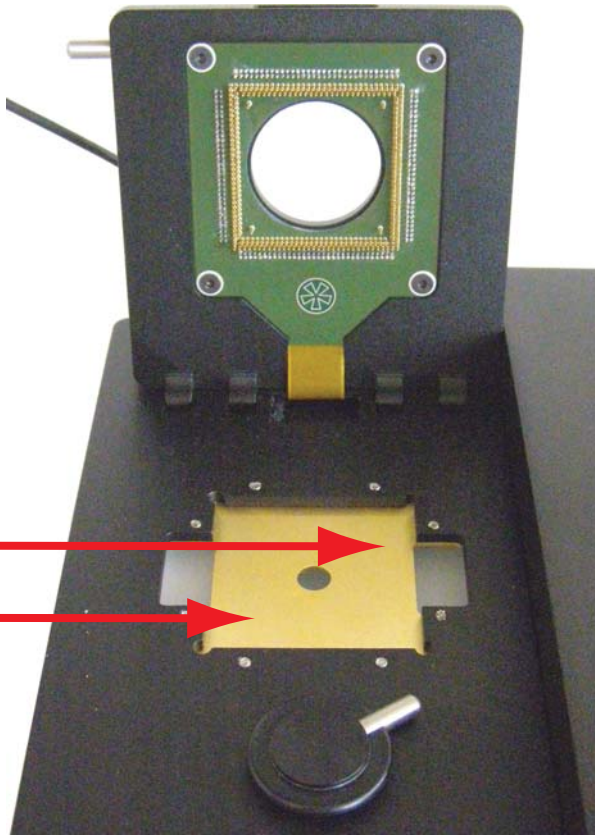
9-Well macrolon quadrat for 256-9wellMEA.



256-9wellMEA with macrolon quadrat and 9well-CC ring to use it as a culture chamber. Please insert a foil between quadrat and ring.

Please insert the 256-9wellMEA in correct orientation into the amplifier: If you can not read the “MCS”, use the black reference electrodes as marker.





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256-9wellMEA

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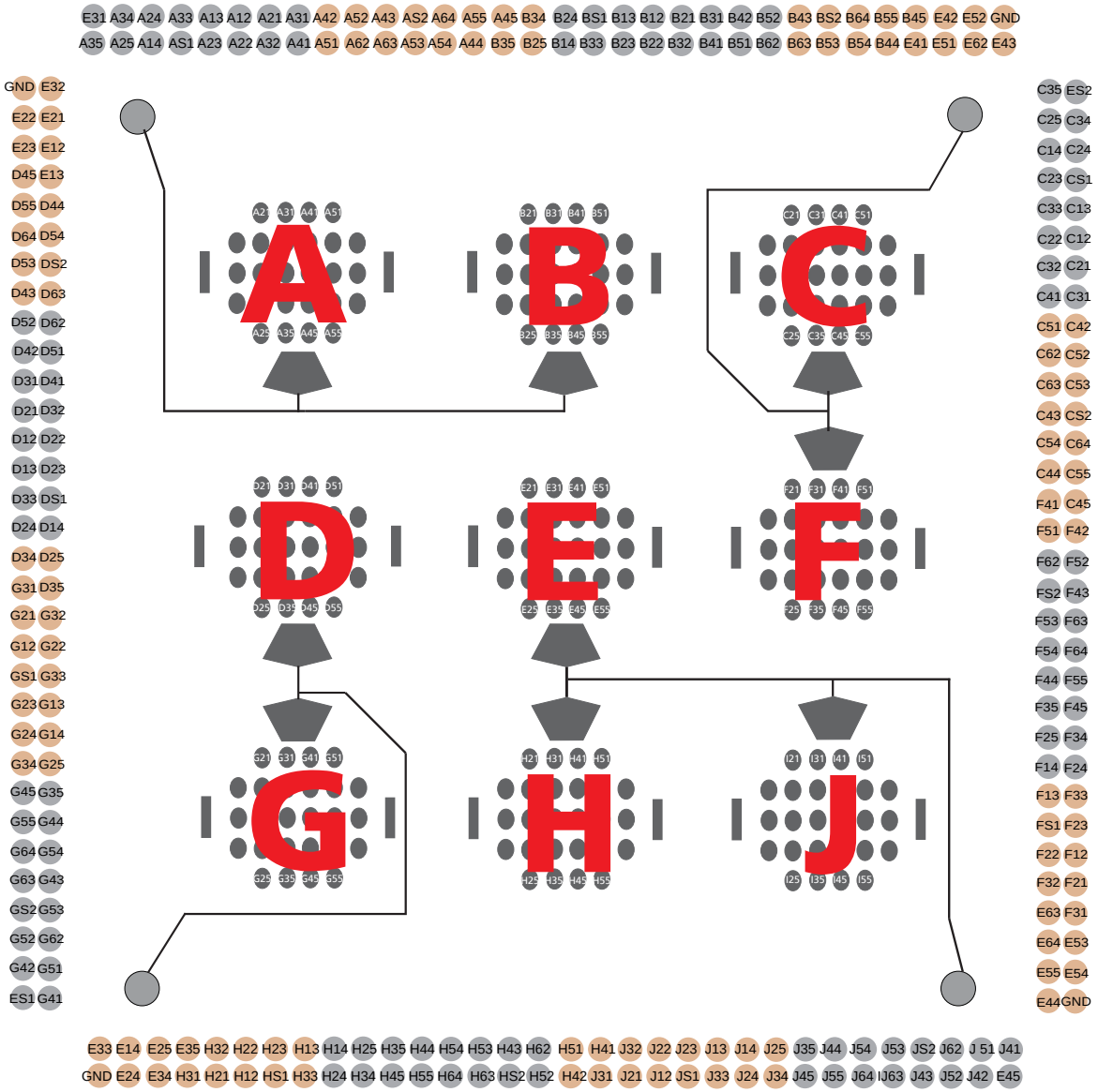

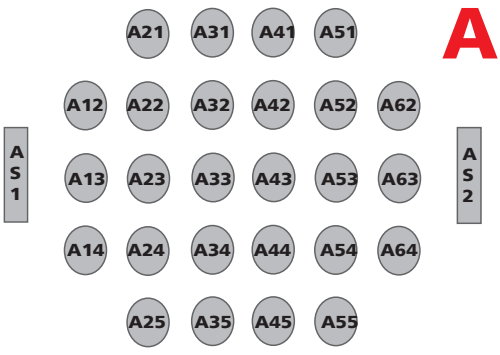

Example Well A : The numbering of MEA electrodes in the 6 x 5 grid per each well follows the standard numbering scheme for square grids:
The first digit is the column number and the second digit is the row number. For example, electrode 23 is positioned in the second column of the third row.
Two square electrodes (S1 and S2) per well are available for stimulation or recording.
There is one big internal reference electrode in each well. The nine reference electrodes are connected to four contact pads for grounding them.

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Tables:
Electrode ID and number of stimulation connector socket in well A, B, and C.

Well A		Well B		Well C	
Electrode ID	Stimulation Socket	Electrode ID	Stimulation Socket	Electrode ID	Stimulation Socket
AS1	Conn. 1 No. 7	BS1	Conn. 1 No. 36	CS1	Conn. 2 No. 8
A12	Conn. 1 No. 12	B12	Conn. 1 No. 40	C12	Conn. 2 No. 12
A13	Conn. 1 No. 10	B13	Conn. 1 No. 38	C13	Conn. 2 No. 10
A14	Conn. 1 No. 5	B14	Conn. 1 No. 33	C14	Conn. 2 No. 5
A21	Conn. 1 No. 14	B21	Conn. 1 No. 42	C21	Conn. 2 No. 14
A22	Conn. 1 No. 11	B22	Conn. 1 No. 39	C22	Conn. 2 No. 11
A23	Conn. 1 No. 9	B23	Conn. 1 No. 37	C23	Conn. 2 No. 7
A24	Conn. 1 No. 6	B24	Conn. 1 No. 34	C24	Conn. 2 No. 6
A25	Conn. 1 No. 3	B25	Conn. 1 No. 31	C25	Conn. 2 No. 3
A31	Conn. 1 No. 16	B31	Conn. 1 No. 44	C31	Conn. 2 No. 16
A32	Conn. 1 No. 13	B32	Conn. 1 No. 41	C32	Conn. 2 No. 13
A33	Conn. 1 No. 8	B33	Conn. 1 No. 35	CS1	Conn. 2 No. 9
A34	Conn. 1 No. 4	B34	Conn. 1 No. 32	C34	Conn. 2 No. 4
A35	Conn. 1 No. 1	B35	Conn. 1 No. 29	C35	Conn. 2 No. 1
A41	Conn. 1 No. 15	B41	Conn. 1 No. 43	C41	Conn. 2 No. 15
A42	Conn. 1 No. 18	B42	Conn. 1 No. 46	C42	Conn. 2 No. 18
A43	Conn. 1 No. 22	B43	Conn. 1 No. 50	C43	Conn. 2 No. 23
A44	Conn. 1 No. 27	B44	Conn. 1 No. 55	C44	Conn. 2 No. 27
A45	Conn. 1 No. 30	B45	Conn. 1 No. 58	C45	Conn. 2 No. 30
A51	Conn. 1 No. 17	B51	Conn. 1 No. 45	C51	Conn. 2 No. 17
A52	Conn. 1 No. 20	B52	Conn. 1 No. 48	C52	Conn. 2 No. 20
A53	Conn. 1 No. 23	B53	Conn. 1 No. 51	C53	Conn. 2 No. 22
A54	Conn. 1 No. 25	B54	Conn. 1 No. 53	C54	Conn. 2 No. 25
A55	Conn. 1 No. 28	B55	Conn. 1 No. 56	C55	Conn. 2 No. 28
A62	Conn. 1 No. 19	B62	Conn. 1 No. 47	C62	Conn. 2 No. 19
A63	Conn. 1 No. 21	B63	Conn. 1 No. 49	C63	Conn. 2 No. 21
A64	Conn. 1 No. 26	B64	Conn. 1 No. 54	C64	Conn. 2 No. 26
AS2	Conn. 1 No. 24	BS2	Conn. 1 No. 52	CS2	Conn. 2 No. 24

Electrode ID and number of stimulation connector socket in well D, E, and F.

Well D		Well E		Well F	
Electrode ID	Stimulation Socket	Electrode ID	Stimulation Socket	Electrode ID	Stimulation Socket
DS1	Conn. 4 No. 35	ES1	Conn. 4 No. 2	FS1	Conn. 2 No. 51
D12	Conn. 4 No. 40	E12	Conn. 4 No. 59	F12	Conn. 2 No. 54
D13	Conn. 4 No. 38	E13	Conn. 4 No. 57	F13	Conn. 2 No. 49
D14	Conn. 4 No. 33	E14	Conn. 3 No. 61	F14	Conn. 2 No. 47
D21	Conn. 4 No. 42	E21	Conn. 4 No. 61	F21	Conn. 2 No. 56
D22	Conn. 4 No. 39	E22	Conn. 4 No. 62	F22	Conn. 2 No. 53
D23	Conn. 4 No. 37	E23	Conn. 4 No. 60	F23	Conn. 2 No. 52
D24	Conn. 4 No. 34	E24	Conn. 3 No. 62	F24	Conn. 2 No. 48
D25	Conn. 4 No. 31	E25	Conn. 3 No. 59	F25	Conn. 2 No. 45
D31	Conn. 4 No. 44	E31	Conn. 1 No. 2	F31	Conn. 2 No. 58
D32	Conn. 4 No. 41	E32	Conn. 4 No. 63	F32	Conn. 2 No. 55
D33	Conn. 4 No. 36	E33	Conn. 3 No. 63	F33	Conn. 2 No. 50
D34	Conn. 4 No. 32	E34	Conn. 3 No. 60	F34	Conn. 2 No. 46
D35	Conn. 4 No. 29	E35	Conn. 3 No. 57	F35	Conn. 2 No. 43
D41	Conn. 4 No. 43	E41	Conn. 1 No. 57	F41	Conn. 2 No. 29
D42	Conn. 4 No. 46	E42	Conn. 1 No. 60	F42	Conn. 2 No. 32
D43	Conn. 4 No. 50	E43	Conn. 1 No. 63	F43	Conn. 2 No. 36
D44	Conn. 4 No. 55	E44	Conn. 2 No. 63	F44	Conn. 2 No. 41
D45	Conn. 4 No. 58	E45	Conn. 3 No. 2	F45	Conn. 2 No. 44
D51	Conn. 4 No. 45	E51	Conn. 1 No. 59	F51	Conn. 2 No. 31
D52	Conn. 4 No. 48	E52	Conn. 1 No. 62	F52	Conn. 2 No. 34
D53	Conn. 4 No. 52	E53	Conn. 2 No. 60	F53	Conn. 2 No. 37
D54	Conn. 4 No. 53	E54	Conn. 2 No. 62	F54	Conn. 2 No. 39
D55	Conn. 4 No. 56	E55	Conn. 2 No. 61	F55	Conn. 2 No. 42
D62	Conn. 4 No. 47	E62	Conn. 1 No. 61	F62	Conn. 2 No. 33
D63	Conn. 4 No. 49	E63	Conn. 2 No. 57	F63	Conn. 2 No. 38
D64	Conn. 4 No. 54	E64	Conn. 2 No. 59	F64	Conn. 2 No. 40
DS2	Conn. 4 No. 51	ES2	Conn. 2 No. 2	FS2	Conn. 2 No. 35

Electrode ID and number of stimulation connector socket in well G, H, and J.

Well G		Well H		Well J	
Electrode ID	Stimulation Socket	Electrode ID	Stimulation Socket	Electrode ID	Stimulation Socket
GS1	Conn. 4 No. 24	HS1	Conn. 3 No. 52	JS1	Conn. 3 No. 24
G12	Conn. 4 No. 26	H12	Conn. 3 No. 54	J12	Conn. 3 No. 26
G13	Conn. 4 No. 21	H13	Conn. 3 No. 49	J13	Conn. 3 No. 21
G14	Conn. 4 No. 19	H14	Conn. 3 No. 47	J14	Conn. 3 No. 19
G21	Conn. 4 No. 28	H21	Conn. 3 No. 56	J21	Conn. 3 No. 28
G22	Conn. 4 No. 25	H22	Conn. 3 No. 53	J22	Conn. 3 No. 25
G23	Conn. 4 No. 22	H23	Conn. 3 No. 51	J23	Conn. 3 No. 23
G24	Conn. 4 No. 20	H24	Conn. 3 No. 48	J24	Conn. 3 No. 20
G25	Conn. 4 No. 17	H25	Conn. 3 No. 45	J25	Conn. 3 No. 17
G31	Conn. 4 No. 30	H31	Conn. 3 No. 58	J31	Conn. 3 No. 30
G32	Conn. 4 No. 27	H32	Conn. 3 No. 55	J32	Conn. 3 No. 27
G33	Conn. 4 No. 23	H33	Conn. 3 No. 50	J33	Conn. 3 No. 22
G34	Conn. 4 No. 18	H34	Conn. 3 No. 46	J34	Conn. 3 No. 18
G35	Conn. 4 No. 15	H35	Conn. 3 No. 43	J35	Conn. 3 No. 15
G41	Conn. 4 No. 1	H41	Conn. 3 No. 29	J41	Conn. 3 No. 1
G42	Conn. 4 No. 4	H42	Conn. 3 No. 32	J42	Conn. 3 No. 4
G43	Conn. 4 No. 9	H43	Conn. 3 No. 35	J43	Conn. 3 No. 8
G44	Conn. 4 No. 13	H44	Conn. 3 No. 41	J44	Conn. 3 No. 13
G45	Conn. 4 No. 16	H45	Conn. 3 No. 44	J45	Conn. 3 No. 16
G51	Conn. 4 No. 3	H51	Conn. 3 No. 31	J51	Conn. 3 No. 3
G52	Conn. 4 No. 6	H52	Conn. 3 No. 34	J52	Conn. 3 No. 6
G53	Conn. 4 No. 7	H53	Conn. 3 No. 37	J53	Conn. 3 No. 9
G54	Conn. 4 No. 11	H54	Conn. 3 No. 39	J54	Conn. 3 No. 11
G55	Conn. 4 No. 14	H55	Conn. 3 No. 42	J55	Conn. 3 No. 14
G62	Conn. 4 No. 5	H62	Conn. 3 No. 33	J62	Conn. 3 No. 5
G63	Conn. 4 No. 10	H63	Conn. 3 No. 38	J63	Conn. 3 No. 10
G64	Conn. 4 No. 12	H64	Conn. 3 No. 40	J64	Conn. 3 No. 12
GS2	Conn. 4 No. 8	HS2	Conn. 3 No. 36	JS2	Conn. 3 No. 7

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256-9wellMEA

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Connector 1			
Stim Socket	Electrode ID	Spring Con.	Hardware ID
1	A35	2	226
2	E31	1	196
3	A25	3	158
4	A34	133	130
5	A14	4	223
6	A24	134	193
7	AS1	5	155
8	A33	135	253
9	A23	6	224
10	A13	136	194
11	A22	7	156
12	A12	137	254
13	A32	8	123
14	A21	138	93
15	A41	9	55
16	A31	139	25
17	A51	10	124
18	A42	140	94
19	A62	11	56
20	A52	141	26
21	A63	12	121
22	A43	142	91
23	A53	13	53
24	AS2	143	23
25	A54	14	122
26	A64	144	92
27	A44	15	54
28	A55	145	24
29	B35	16	119
30	A45	146	89
31	B25	17	51
32	B34	147	21
33	B14	18	120
34	B24	148	90
35	B33	19	52
36	BS1	149	22
37	B23	20	117
38	B13	150	87
39	B22	21	49
40	B12	151	19
41	B32	22	118
42	B21	152	88
43	B41	23	50
44	B31	153	20
45	B51	24	115
46	B42	154	85
47	B62	25	47
48	B52	155	17
49	B63	26	116
50	B43	156	86
51	B53	27	48
52	BS2	157	18
53	B54	28	113
54	B64	158	83
55	B44	29	45
56	B55	159	15
57	E41	30	114
58	B45	160	84
59	E51	31	46
60	E42	161	16
61	E62	32	111
62	E52	162	81
63	E43	33	43
GND			

Connector 2			
Stim Socket	Electrode ID	Spring Con.	Hardware ID
1	C35	35	112
2	ES2	34	82
3	C25	36	44
4	C34	163	13
5	C14	37	109
6	C24	164	79
7	C23	38	41
8	CS1	165	14
9	C33	39	110
10	C13	166	80
11	C22	40	42
12	C12	167	11
13	C32	41	107
14	C21	168	77
15	C41	42	39
16	C31	169	12
17	C51	43	108
18	C42	170	78
19	C62	44	40
20	C52	171	9
21	C63	45	105
22	C53	172	75
23	C43	46	37
24	CS2	173	10
25	C54	47	106
26	C64	174	76
27	C44	48	38
28	C55	175	7
29	F41	49	103
30	C45	176	73
31	F51	50	35
32	F42	177	8
33	F62	51	104
34	F52	178	74
35	FS2	52	36
36	F43	179	5
37	F53	53	101
38	F63	180	71
39	F54	54	33
40	F64	181	6
41	F44	55	102
42	F55	182	72
43	F35	56	34
44	F45	183	3
45	F25	57	99
46	F34	184	69
47	F14	58	31
48	F24	185	4
49	F13	59	100
50	F33	186	70
51	FS1	60	32
52	F23	187	1
53	F22	61	97
54	F12	188	67
55	F32	62	29
56	F21	189	2
57	E63	63	98
58	F31	190	68
59	E64	64	30
60	E53	191	125
61	E55	65	95
62	E54	192	65
63	E44	66	27
GND			

Connector 3			
Stim Socket	Electrode ID	Spring Con.	Hardware ID
1	J41	68	96
2	E45	67	66
3	J51	69	28
4	J42	193	126
5	J62	70	64
6	J52	194	214
7	JS2	71	63
8	J43	195	217
9	J53	72	244
10	J63	196	216
11	J54	73	247
12	J64	197	219
13	J44	74	246
14	J55	198	218
15	J35	75	249
16	J45	199	222
17	J25	76	248
18	J34	200	220
19	J14	77	252
20	J24	201	221
21	J13	78	250
22	J33	202	58
23	J23	79	251
24	JS1	203	57
25	J22	80	146
26	J12	204	60
27	J32	81	149
28	J21	205	59
29	H41	82	148
30	J31	206	62
31	H51	83	151
32	H42	207	61
33	H62	84	150
34	H52	208	186
35	H43	85	154
36	HS2	209	185
37	H53	86	152
38	H63	210	188
39	H54	87	153
40	H64	211	187
41	H44	88	176
42	H55	212	190
43	H35	89	175
44	H45	213	189
45	H25	90	178
46	H34	214	192
47	H14	91	177
48	H24	215	191
49	H13	92	180
50	H33	216	145
51	H23	93	179
52	HS1	217	147
53	H22	94	182
54	H12	218	243
55	H32	95	181
56	H21	219	245
57	E35	96	184
58	H31	220	213
59	E25	97	183
60	E34	221	215
61	E14	98	239
62	E24	222	209
63	E33	99	171
GND			

Connector 4			
Stim Socket	Electrode ID	Spring Con.	Hardware ID
1	G41	101	240
2	ES1	100	210
3	G51	102	172
4	G42	223	141
5	G62	103	241
6	G52	224	211
7	G53	104	173
8	GS2	225	142
9	G43	105	242
10	G63	226	212
11	G54	106	174
12	G64	227	143
13	G44	107	237
14	G55	228	207
15	G35	108	169
16	G45	229	144
17	G25	109	238
18	G34	230	208
19	G14	110	170
20	G24	231	139
21	G13	111	235
22	G23	232	205
23	G33	112	167
24	GS1	233	140
25	G22	113	236
26	G12	234	206
27	G32	114	168
28	G21	235	137
29	D35	115	233
30	G31	236	203
31	D25	116	165
32	D34	237	138
33	D14	117	234
34	D24	238	204
35	DS1	118	166
36	D33	239	135
37	D23	119	231
38	D13	240	201
39	D22	120	163
40	D12	241	136
41	D32	121	232
42	D21	242	202
43	D41	122	164
44	D31	243	133
45	D51	123	229
46	D42	244	199
47	D62	124	161
48	D52	245	134
49	D63	125	230
50	D43	246	200
51	DS2	126	162
52	D53	247	162
53	D54	127	227
54	D64	248	197
55	D44	128	159
56	D55	249	132
57	E13	129	228
58	D45	250	198
59	E12	130	160
60	E23	251	129
61	E21	131	225
62	E22	252	195
63	E32	132	157
GND			

9-Well MEA for use with USB-MEA256-System

Sti. Socket = Stimulation socket number in the connectors 1 to 4.
Spring Contact = Spring contacts in the lid of the amplifier, connecting to the contact pads of the 256-9wellMEA.
Hardware ID = Hardware channel ID of MC_Rack hardware channels, using the linear layout.
Electrode ID = Electrode ID of the MEA electrode in the 9 x 28 layout grid.

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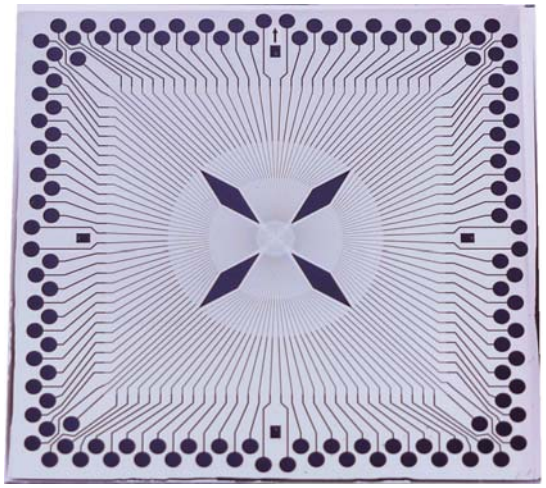
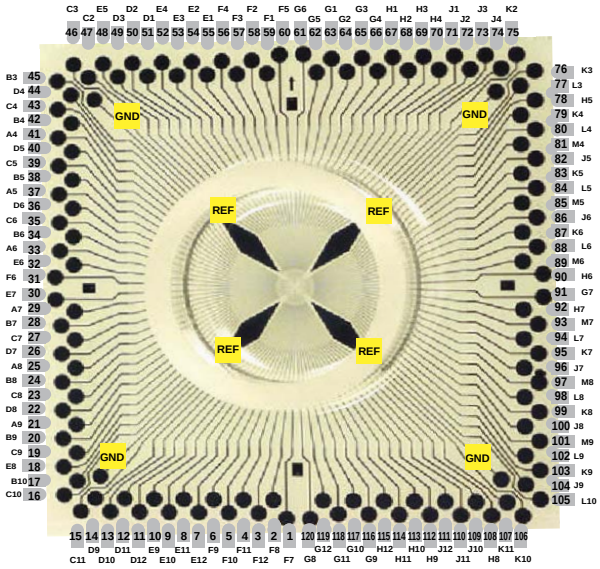
120MEA

120MEA200/30iR-Ti
120MEA100/30iR-ITO
120MEA for Use with MEA2100-120-System with 12 x 12 electrode grid





Technical Specifications 120MEA

Temperature compatibility	0 - 125 °C
Dimension (W x D x H)	49 x 49 x 1 mm
Base material	Glass
Contact pads and track material	Ti (Titanium) or ITO (Indium tin oxide)
Electrode diameter	30 µm
Interelectrode distance (centre to centre)	100 or 200 µm
Electrode height	Planar
Electrode type	TiN (Titanium nitride)
Isolation type	Silicon nitride 500 nm (PEVCD)
Electrode impedance	30 - 50 kΩ electrodes
Electrode layout grid	12 x 12
Number of recording electrodes	120
Number of reference electrodes	4 internal reference electrodes (iR)
Contact pads for reference electrodes, connected to ground	4

MC_Rack	
Source layout in “Data Source Setup”	Configuration
MEA	MEA120 200/30

MEA perfusion chamber

(w/o) Without ring
(gr) Glass ring: ID +/-19 mm, OD 24 mm
(pr) Plastic ring without thread: ID 26.5 mm, OD 30 mm, height 3 / 6 mm
(pr-T) Plastic ring with thread: ID 26 mm, OD 30 mm, height 6 / 15 mm

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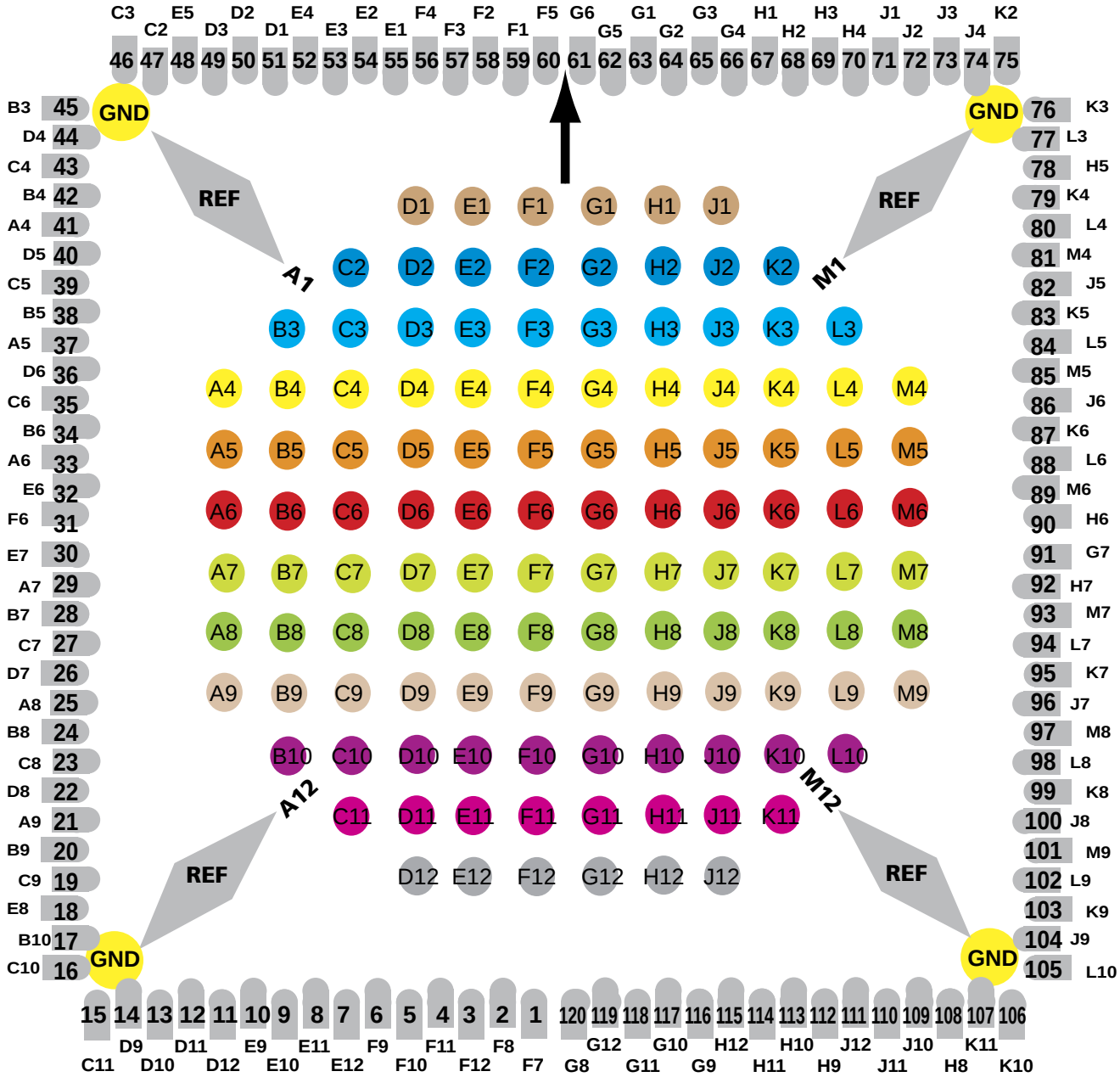
120MEA

120MEA200/30iR-Ti
120MEA100/30iR-ITO



The letter digit code is the electrode identifier, and refers to the position of the electrode in the 12 x 12 layout grid. The number code is the hardware identifier of the electrode. The reference electrodes (REF) are connected to ground (GND).

Please insert the 120MEA in correct orientation when looking from the front into the opened headstage. The small arrow near to the contact pads of the 120MEA faces upwards. Under microscope control you can read the markers A1 and A12, M1 and M12 as shown on the diagram.

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120MEA

120MEA200/30iR-Ti
120MEA100/30iR-ITO

Electrode Layout

Table: Hardware ID and Electrode ID

HW ID	EL ID	HW ID	EL ID	HW ID	EL ID	HW ID	EL ID
120	G8	90	H6	60	F5	30	E7
119	G12	89	M6	59	F1	29	A7
118	G11	88	L6	58	F2	28	B7
117	G10	87	K6	57	F3	27	C7
116	G9	86	J6	56	F4	26	D7
115	H12	85	M5	55	E1	25	A8
114	H11	84	L5	54	E2	24	B8
113	H10	83	K5	53	E3	23	C8
112	H9	82	J5	52	E4	22	D8
111	J12	81	M4	51	D1	21	A9
110	J11	80	L4	50	D2	20	B9
109	J10	79	K4	49	D3	19	C9
108	H8	78	H5	48	E5	18	E8
107	K11	77	L3	47	C2	17	B10
106	K10	76	K3	46	C3	16	C10
105	L10	75	K2	45	B3	15	C11
104	J9	74	J4	44	D4	14	D9
103	K9	73	J3	43	C4	13	D10
102	L9	72	J2	42	B4	12	D11
101	M9	71	J1	41	A4	11	D12
100	J8	70	H4	40	D5	10	E9
99	K8	69	H3	39	C5	9	E10
98	L8	68	H2	38	B5	8	E11
97	M8	67	H1	37	A5	7	E12
96	J7	66	G4	36	D6	6	F9
95	K7	65	G3	35	C6	5	F10
94	L7	64	G2	34	B6	4	F11
93	M7	63	G1	33	A6	3	F12
92	H7	62	G5	32	E6	2	F8
91	G7	61	G6	31	F6	1	F7

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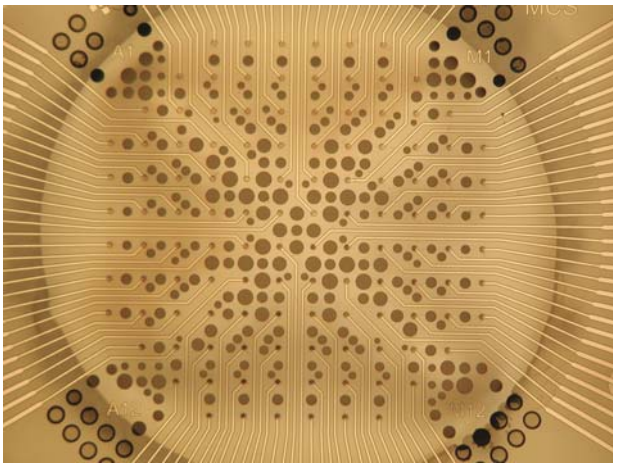
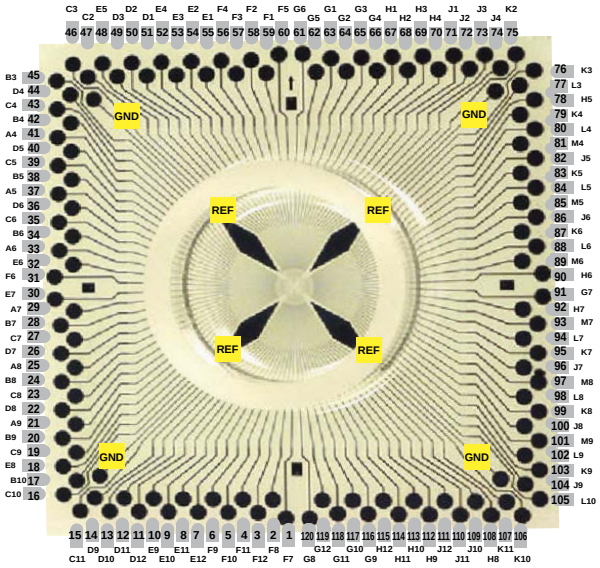
120pMEA200/30iR-Ti

120pMEA for Use with MEA2100-120-System

Layout with 12 x 12 electrode grid





Technical Specifications 120pMEA200/30iR-Ti

Temperature compatibility	0 - 50 °C
Dimension (W x D x H)	49 x 49 x 1 mm
Base material	Polyimide foil (2611) with perforation on glass carrier
Perforation:	
Diameter of innermost area	3 - 4 mm
Total area of holes	9-12 % (according to 3 - 4 mm)
Diameter of the holes	15, 20, 25, 30, 40, 45, 50 µm
Contact pads	TiAu (Titan, Gold)
Track material	TiAuTi (Titan, Gold, Titan)
Electrode diameter	30 µm
Interelectrode distance (centre to centre)	200 µm
Electrode height	Planar
Electrode type	TiN (Titanium nitride)
Isolation type	Polyimide foil (2610) isolator
Electrode impedance	30 - 50 kΩ electrodes
Electrode layout grid	12 x 12
Number of recording electrodes	120
Number of reference electrodes	4 internal reference electrodes (iR)
Contact pads for reference electrodes, connected to ground	4
MC_Rack	
Source layout in “Data Source Setup”	Configuration
MEA	MEA120 200/30

Rinse with distilled water. Do not use ultrasonic bath!
These perforated MEAs are not heat stable, and should not be autoclaved!

MEA perfusion chamber

(w/o) Without ring
(gr) Glass ring: ID +/-19 mm, OD 24 mm
(pr) Plastic ring without thread: ID 26.5 mm, OD 30 mm, height 3 / 6 mm
(pr-T) Plastic ring with thread: ID 26 mm, OD 30 mm, height 6 / 15 mm

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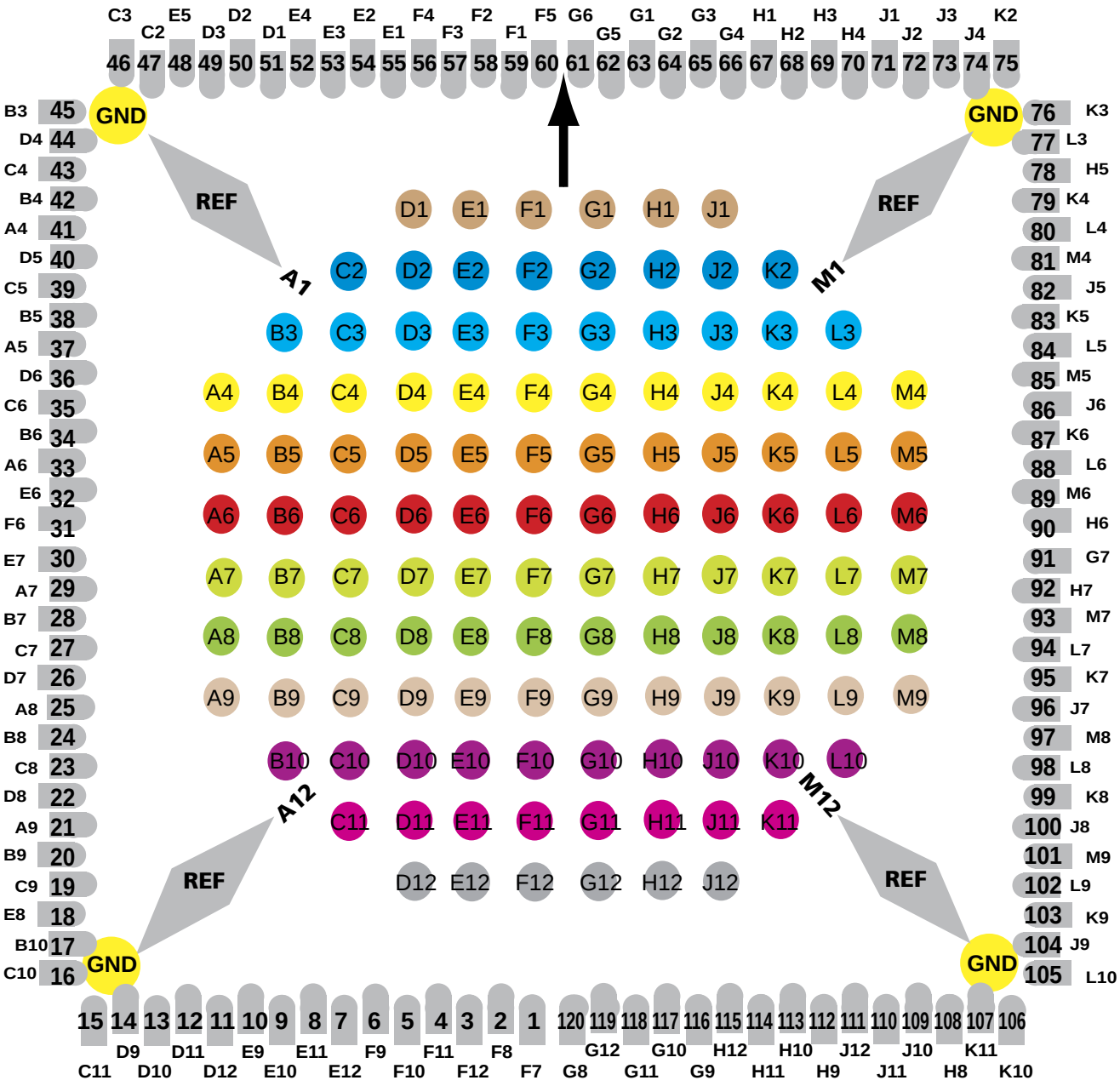
120pMEA200/30iR-Ti



The letter digit code is the electrode identifier, and refers to the position of the electrode in the 12 x 12 layout grid. The number code is the hardware identifier of the electrode. The reference electrodes (REF) are connected to ground (GND).

Please insert the 120pMEA in correct orientation when looking from the front into the opened headstage. The small arrow near to the contact pads of the 120pMEA faces upwards. Under microscope control you can read the markers A1 and A12, M1 and M12 as shown on the diagram.

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120pMEA200/30iR-Ti

Electrode Layout

Table: Hardware ID and Electrode ID

HW ID	EL ID	HW ID	EL ID	HW ID	EL ID	HW ID	EL ID
120	G8	90	H6	60	F5	30	E7
119	G12	89	M6	59	F1	29	A7
118	G11	88	L6	58	F2	28	B7
117	G10	87	K6	57	F3	27	C7
116	G9	86	J6	56	F4	26	D7
115	H12	85	M5	55	E1	25	A8
114	H11	84	L5	54	E2	24	B8
113	H10	83	K5	53	E3	23	C8
112	H9	82	J5	52	E4	22	D8
111	J12	81	M4	51	D1	21	A9
110	J11	80	L4	50	D2	20	B9
109	J10	79	K4	49	D3	19	C9
108	H8	78	H5	48	E5	18	E8
107	K11	77	L3	47	C2	17	B10
106	K10	76	K3	46	C3	16	C10
105	L10	75	K2	45	B3	15	C11
104	J9	74	J4	44	D4	14	D9
103	K9	73	J3	43	C4	13	D10
102	L9	72	J2	42	B4	12	D11
101	M9	71	J1	41	A4	11	D12
100	J8	70	H4	40	D5	10	E9
99	K8	69	H3	39	C5	9	E10
98	L8	68	H2	38	B5	8	E11
97	M8	67	H1	37	A5	7	E12
96	J7	66	G4	36	D6	6	F9
95	K7	65	G3	35	C6	5	F10
94	L7	64	G2	34	B6	4	F11
93	M7	63	G1	33	A6	3	F12
92	H7	62	G5	32	E6	2	F8
91	G7	61	G6	31	F6	1	F7

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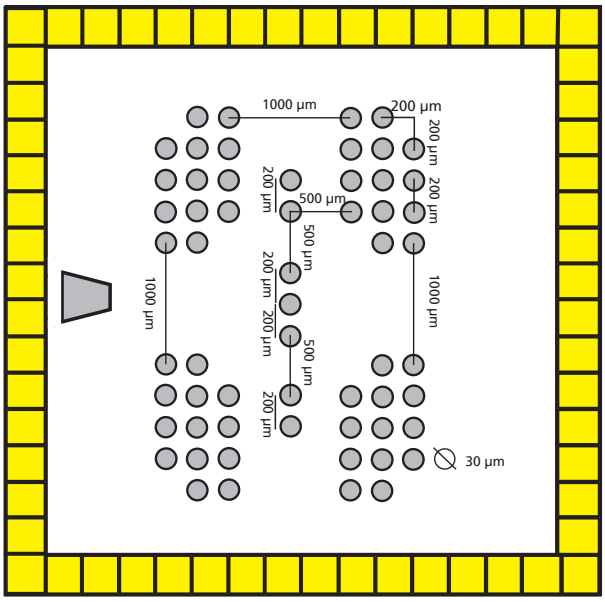
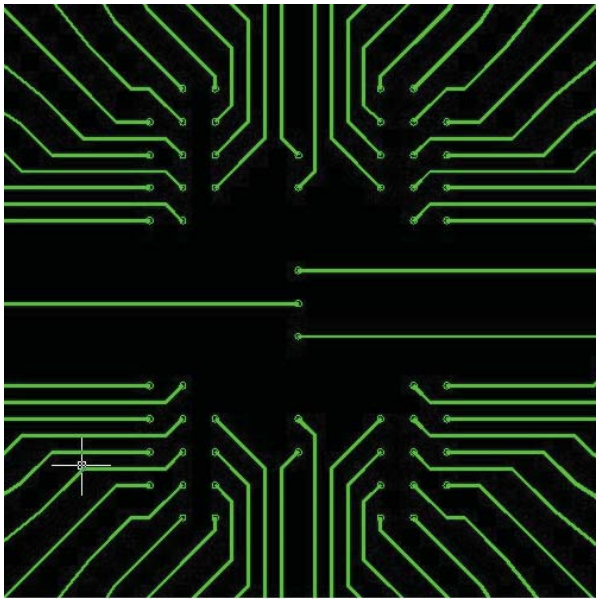
60-4QMEA1000

60-4QMEA1000iR-Ti

multichannel systems

Four Quadrants Microelectrode Array





Technical Specifications 60-4QMEA1000

Temperature compatibility	0 - 125 °C
Dimension (W x D x H)	49 mm x 49 mm x 1 mm
Base material	Glass
Track material	Ti (Titanium)
Contact pads	TiN (Titanium nitride)
Electrode diameter	30 µm
Interelectrode distance (centre to centre)	200 µm inside of the quadrants 1000 µm between the quadrants 500 µm from quadrants to the center line
Electrode height	Planar
Electrode type	TiN (Titanium nitride)
Isolation type	Silicon nitride 500 nm (PEVCD)
Electrode impedance	Approximately 30 - 50 kΩ
Electrode layout grid	4 x (1 x 4 + 1 x 5 + 1 x 4) + center line 1 x 7
Number of recording electrodes	59
Number of reference electrodes	1 internal reference electrode (iR)
MC_Rack:	
Source layout in “Data Source Setup”	2 dim (MEA)
Channel map	4QMEA.cmp

MEA perfusion chamber	(w/o)	Without ring
	(gr)	Glass ring: ID +/- 19 mm, OD 24 mm, height 6 / 12 mm
	(pr)	Plastic ring without thread: ID 26.5 mm, OD 30 mm, height 6 / 3 mm
	(pr-T)	Plastic ring with thread: ID 26 mm, OD 30 mm, height 6 / 15 mm

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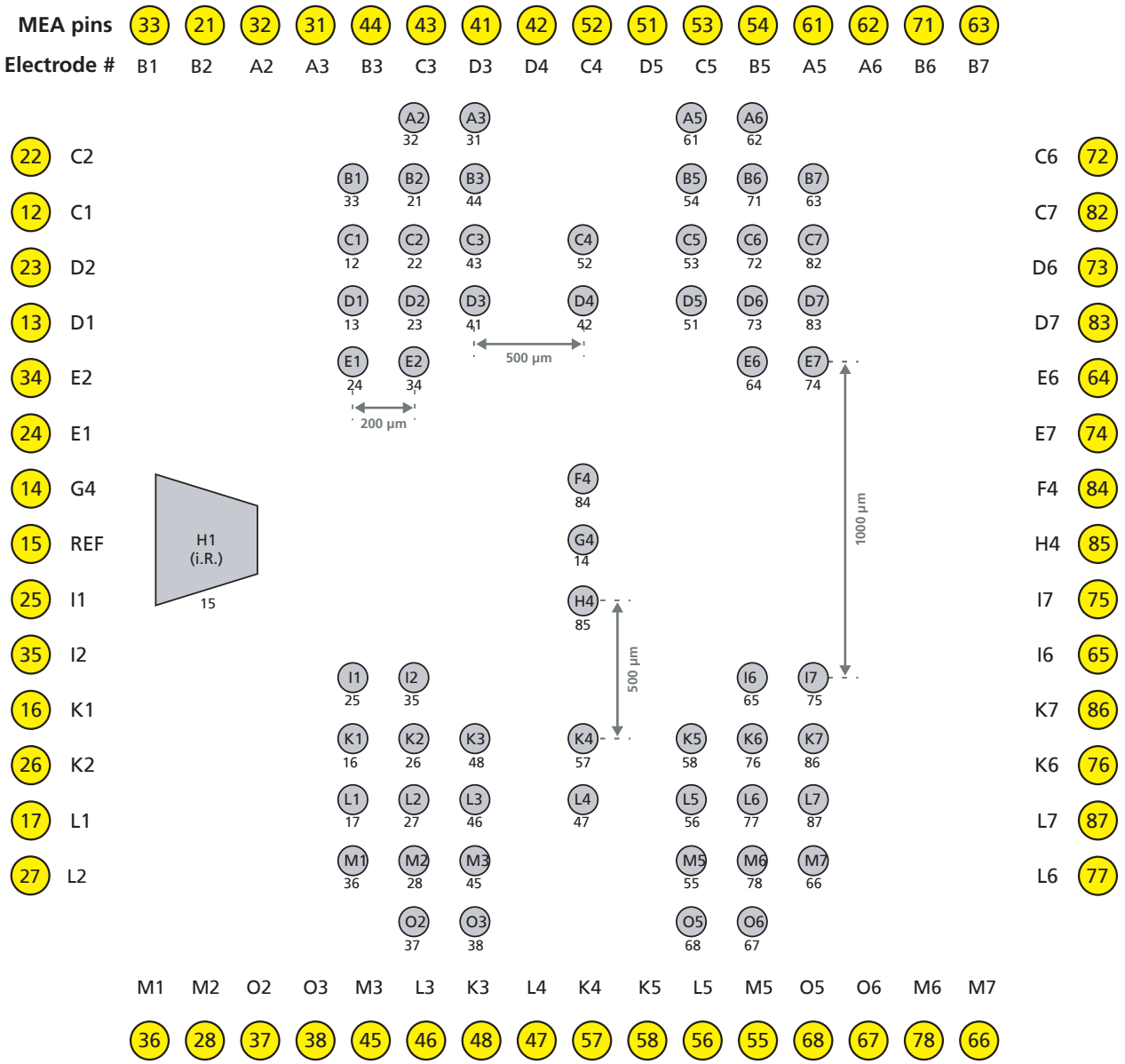
60-4QMEA1000

60-4QMEA1000iR-Ti

Electrode layout



The letter-digit code is the electrode identifier and refers to the position of the electrode in the four quadrant grid. The specified MEA amplifier pin numbers are the channel numbers that are used in MC_Rack, when using the 2 dimensional layout in “Data Source Setup”.

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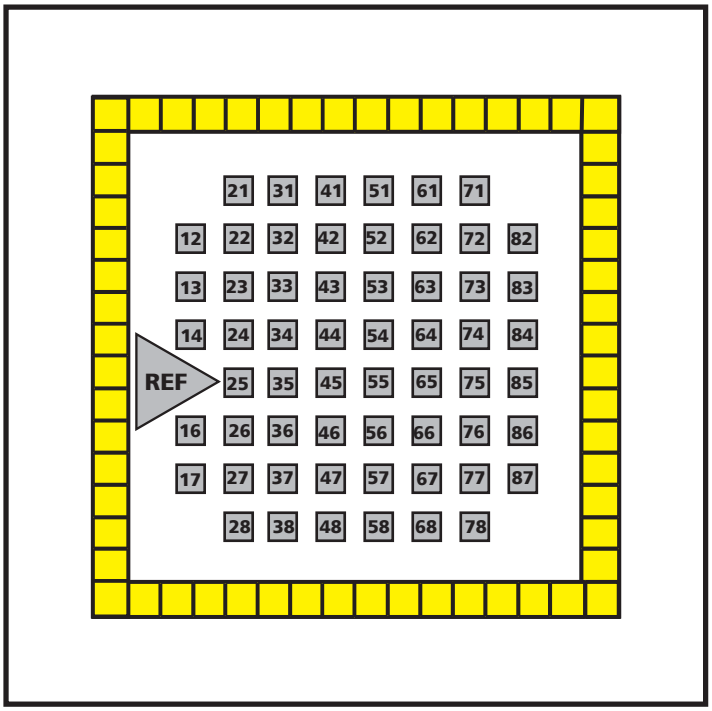
60SquareMEA200/50iR-Ti

Microelectrode Array with 60 square electrodes



Technical Specifications 60SquareMEA200/50iR-Ti

Temperature compatibility	0 - 125 °C
Dimension (W x D x H)	49 mm x 49 mm x 1 mm
Base material	Glass
Track material	Ti (Titanium)
Contact pads	TiN (Titanium nitride)
Electrode square size	50 x 50 µm
Interelectrode distance (centre to centre)	200 µm
Electrode height	Planar
Electrode type	TiN (Titanium nitride)
Isolation type	Silicon nitride 500 nm (PEVCD)
Electrode impedance	30 - 50 kΩ
Electrode layout grid	8 x 8
Number of recording electrodes	59
Number of reference electrodes	1 internal reference electrode (iR)
MC_Rack	
Source layout in “Data Source Setup”	2 dim. (MEA)
Channel map	Default

MEA perfusion chamber	(w/o)	Without ring
	(gr)	Glass ring: ID +/- 19 mm, OD 24 mm, height 6 / 12 mm
	(pr)	Plastic ring without thread: ID 26.5 mm, OD 30 mm, height 6 / 3 mm
	(pr-T)	Plastic ring with thread: ID 26 mm, OD 30 mm, height 6 / 15 mm

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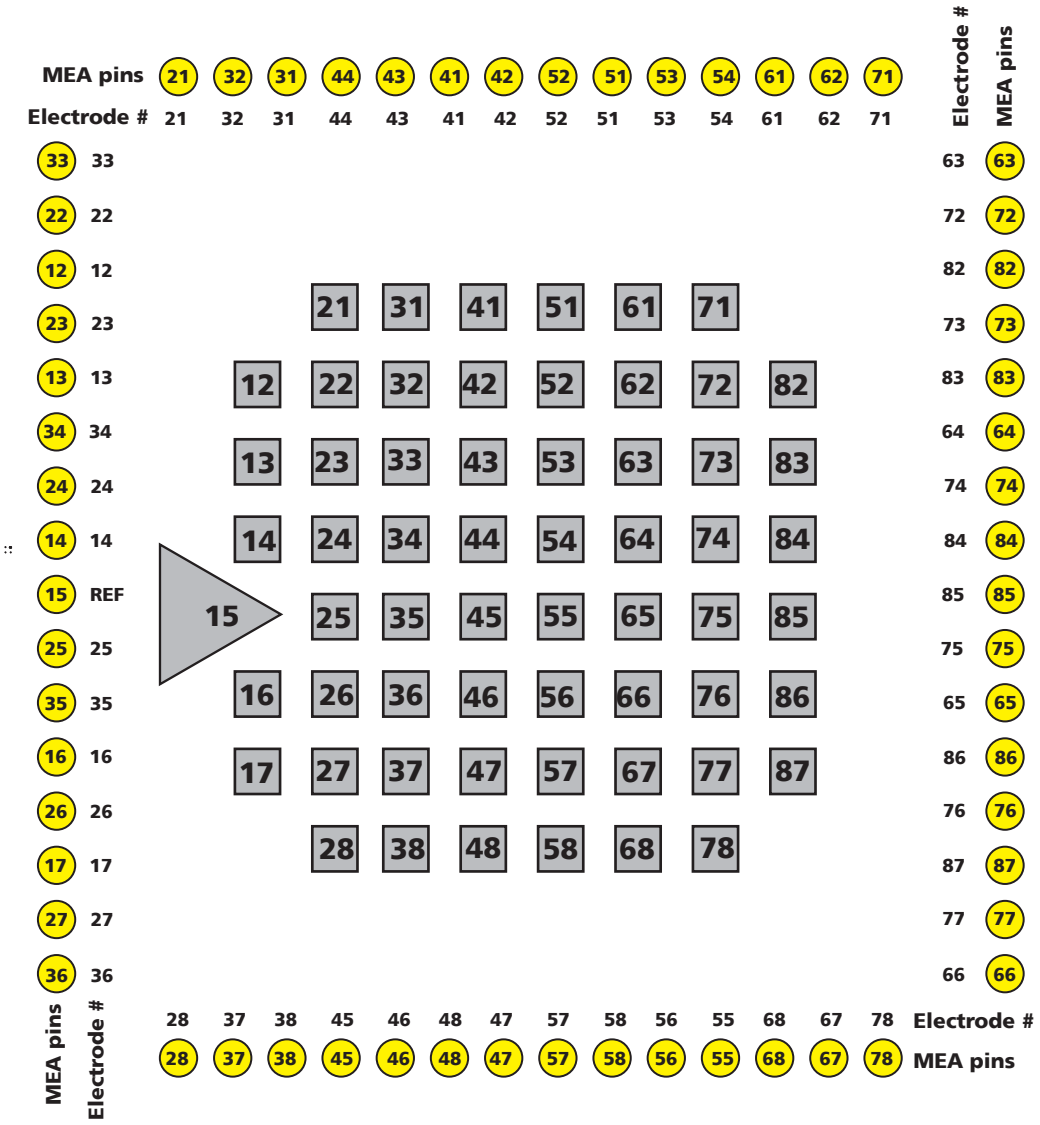
60SquareMEA200/50iR-Ti

Microelectrode Array with 60 square electrodes

Standard electrode layout grid 8 x 8



The numbering of MEA electrodes in the 8 x 8 grid follows the standard numbering scheme for square grids: The first digit is the column number, and the second digit is the row number. For example, electrode 23 is positioned in the third row of the second column.

The specified MEA pin numbers are the channel numbers that are used in the MC_Rack program, when using the 2 dimensional layout in “Data Source Setup”. The electrode 15 is replaced by a big internal reference electrode.

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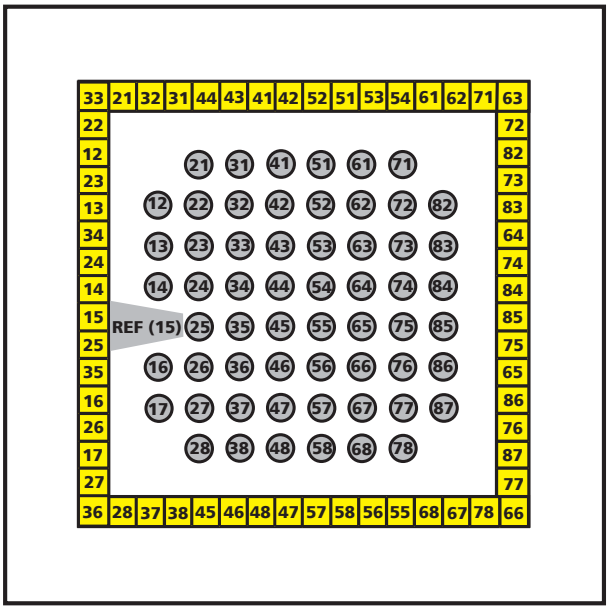
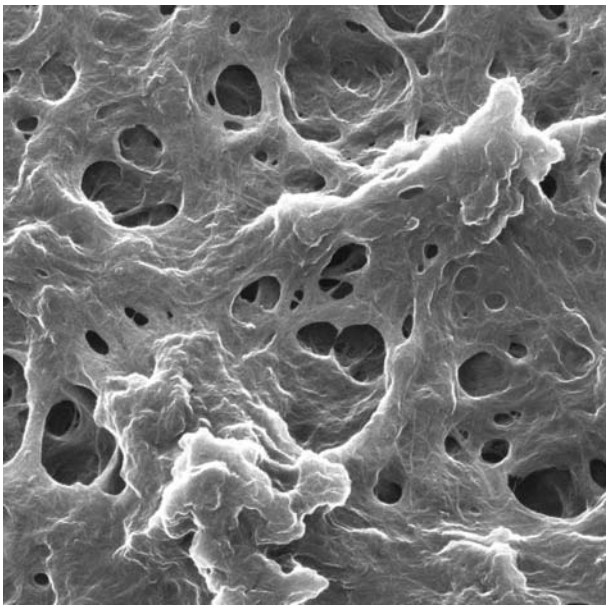
60PedotMEA200/30iR-Au

Microelectrode Array with PEDOT-CNT Electrodes





Carbon nanotube stucture of PEDOT electrodes (3 µm)

Technical Specifications 60PedotMEA

Temperature compatibility		0 - 125 °C
Dimension (W x D x H)		49 mm x 49 mm x 1 mm
Base material		Glass
Contact pads and track material		Ti-Au (Titanium-Gold)
Electrode diameter		30 µm
Interelectrode distance (centre to centre)		200 µm
Electrode height		Planar
Electrode type		PEDOT-CNT (carbon nanotube – poly 3,4-ethylene-dioxythiophene)
Isolation type		Silicon nitride 500 nm (PEVCD)
Electrode impedance		Approximately 20 kΩ
Electrode layout grid		8 x 8
Number of recording electrodes		59
Number of reference electrodes		1 internal reference electrode
MC_Rack Source layout in “Data Source Setup” Channel map		2 dim. (MEA) or Configuration Default
MEA perfusion chamber	(gr)	Glass ring: ID +/- 19 mm, OD 24 mm, height 6 / 12 mm

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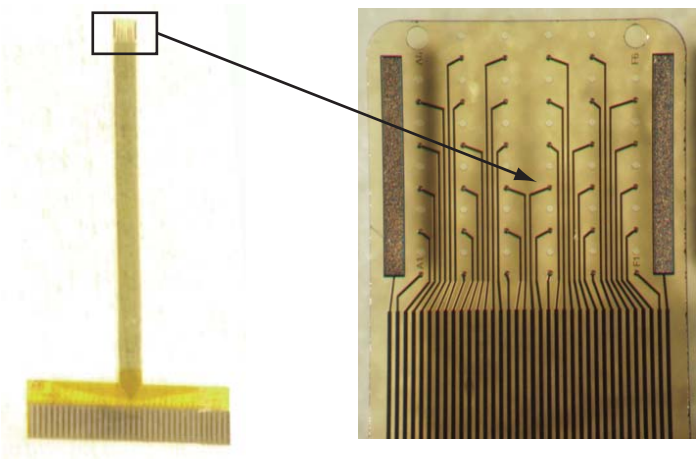
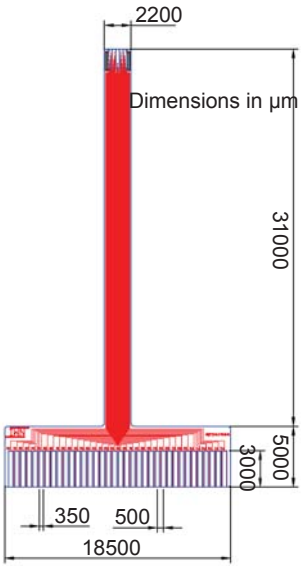
FlexMEA36

Flexible Microelectrode Array with 36 electrodes for use with 32-Channel Miniature Preamplifier MPA32I-Flex or with the ADPT-FM-32 adapter and the standard MPA32I.





Technical Specifications FlexMEA36

Temperature compatibility	10 - 40 °C
Dimension (W x D)	31 mm x 18.5 mm
Thickness of the electrode field	12 µm
Weight	< 1 g
Base material	Polyimide (2611) foil
Contact pads and track material	Gold
Electrode diameter	30 µm
Interelectrode distance (centre to centre)	300 µm
Perforation	Diameters of the holes 30 µm
Electrode height	Planar
Electrode type	TiN electrodes (Titanium nitride)
Isolation type	Polyimide (2610) foil
Electrode impedance	Approximately 50 kΩ
Electrode layout grid	6 x 6
Number of recording electrodes	32
Number of reference electrodes	2 internal reference electrodes
Number of ground electrodes	2
MC_Rack	
Source layout in “Data Source Setup”	Configuration, 64 channels, Amplifier: FA64I/S or FA32I/S, MEA: FlexMEA36 (FlexMEA36.cmp).
Channel Map	“Default Map” in Layout tab of Data Display.
Cleaning	Rinse with distilled water, optional with ethanol 70%.

Do not autoclave or sterilize FlexMEAs by heat. These MEA types are not heat-stable and will be irreversibly damaged! Please do not use ultrasonic bath for cleaning.

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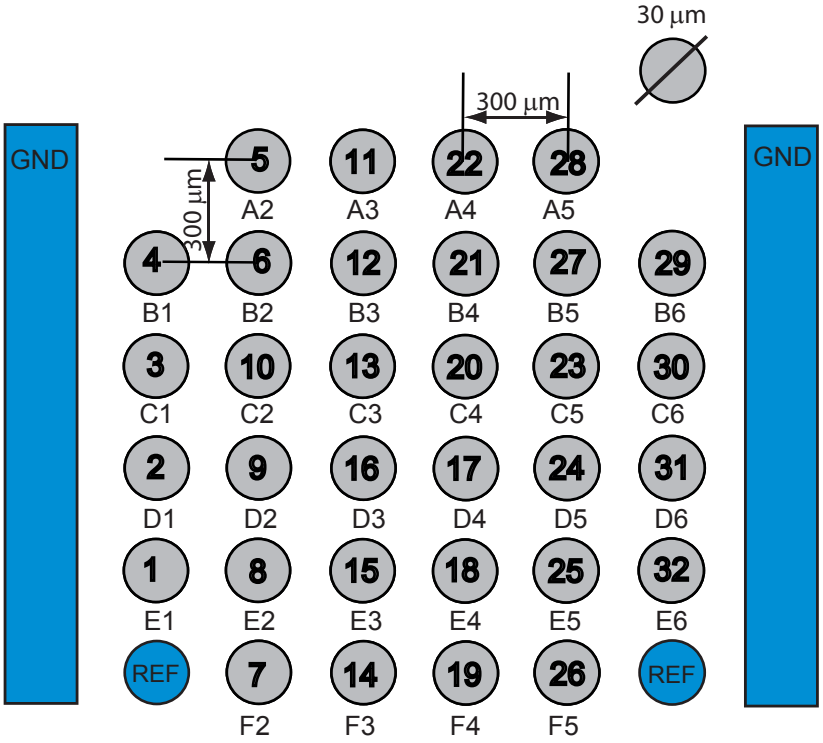
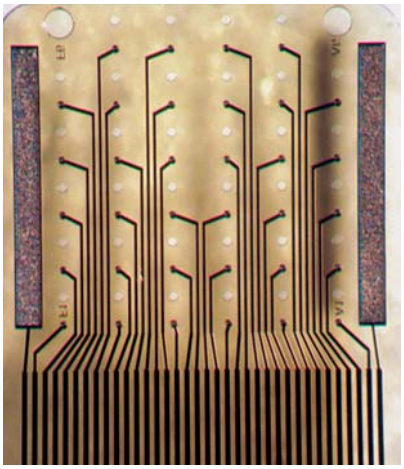
FlexMEA36

Electrode Layout





The numbers in the electrodes are the recording channel numbers that refer to the channel numbers in the MC_Rack program. Please make sure that you have selected “Configuration” in the “Channel Layout” under “Data Source Setup” with a total number of 64 channels. Deselect the check box “Digital input channel” if you do not need it, otherwise it could be that one recording channel is missing! In “Amplifier”, please choose FA32I/S or FA64I/S and in “MEA” FlexMEA36. In Layout tab of the display, please click ”Default Map”.

The letter digit code below is the electrode identifier and refers to the position of the electrode in the grid.

The MC_Rack channel map is constructed by looking on the back side of the electrodes, because the FlexMEA electrodes are placed on the preparation upside down!

If you use more than one MPA32I-Flex and a MEA64-System, the signal collector SC2x32 leads the output channels of the second amplifier to channel number 33 to 64. Please see datasheet SC2x32 for details.

The side with the writing NMI is the correct side with the contact pads and electrodes. It might be a bit confusing that the pads look stronger from the wrong side, but if you hold the FlexMEA into the light, you see that the pads have a 3-dimensional appearance only from the correct side.

Warning: The device may only be used together with the MPA32I (-Flex) from Multi Channel Systems MCS GmbH, and only for the specified purpose. Damage of the device and even injuries can result from improper use.

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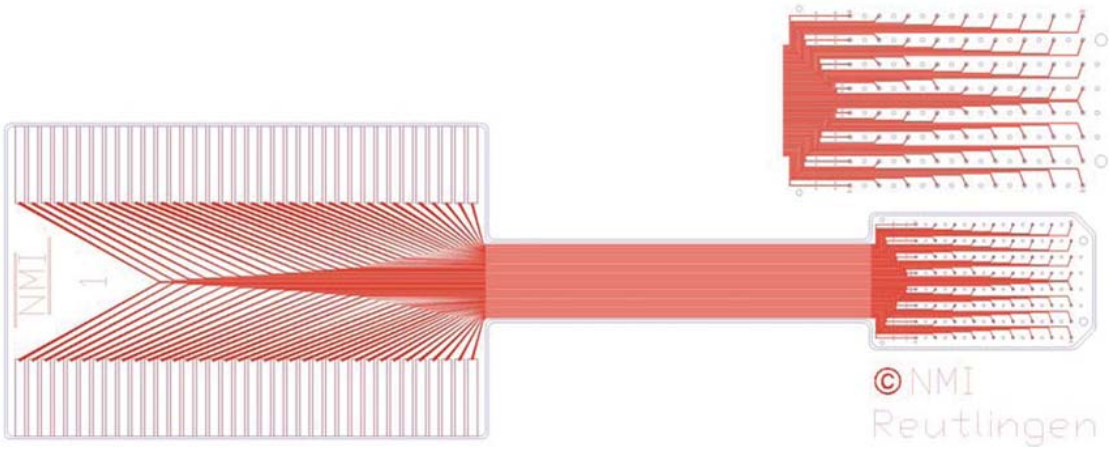
FlexMEA72

Flexible Microelectrode Array with 72 electrodes for use via ADPT-FM-72 adapter with two 32-Channel Miniature Preamplifier MPA32I for *in vivo* and *in vitro* applications.



Technical Specifications FlexMEA72

Temperature compatibility	10 - 40 °C
Dimension (W x D) of the FlexMEA72	42 mm x 12 mm
Thickness of the electrode field	12 µm
Weight	< 1 g
Base material	Polyimide 2611 foil
Contact pads and track material	Gold
Electrode diameter	100 µm
Interelectrode distance (centre to centre)	625 to 750 µm
Perforation	Diameters of the holes 100 µm
Electrode height	Planar
Electrode type	TiN electrodes (Titanium nitride)
Isolation type	Polyimide 2611 foil
Electrode impedance	Approximately 50 kΩ
Electrode layout grid	9 x 8
Number of recording electrodes	64
Number of reference electrodes	4 internal reference electrodes
Number of ground electrodes	4

MC_Rack	Version 4.1.1 and higher
Data Source Setup	Source Layout: Configuration, Total Number of Channels: 64, Amplifier: FA64I/S, MEA: FlexMEA72.
Channel map	Display: Tab Layout > Default Map (FlexMEA72.cmp).
Cleaning	Rinse with distilled water, optional with ethanol 70%.

Do not autoclave or sterilize FlexMEAs by heat. These MEA types are not heat-stable and will be irreversibly damaged! Please do not use an ultrasonic bath for cleaning.

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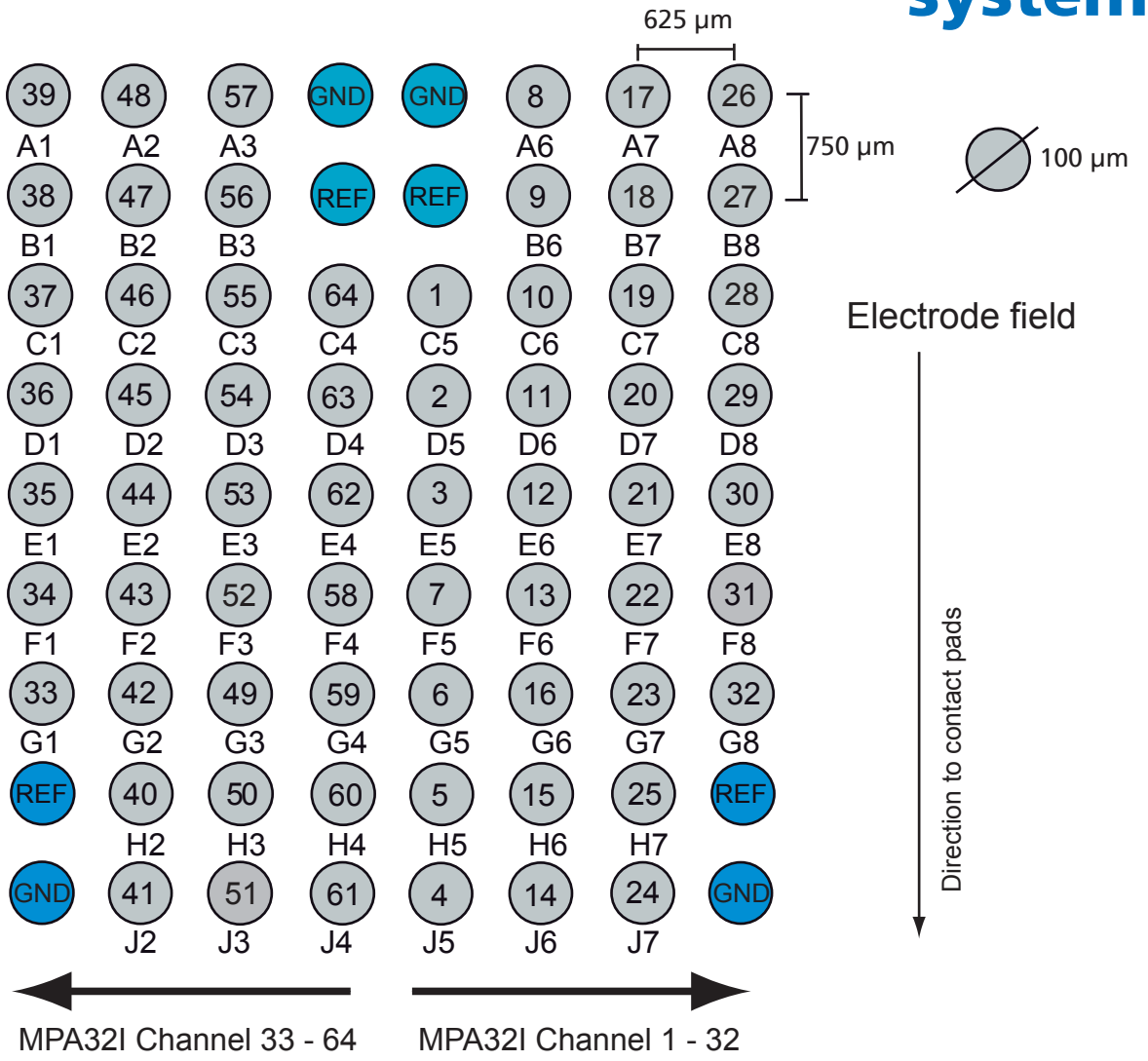
FlexMEA72



The numbers in the electrodes are the recording channel numbers that refer to the channel numbers in the MC_Rack program. Please make sure that you have selected “Configuration” in the “Channel Layout” under “Data Source Setup” with a total number of 64 channels. Deselect the check box “Digital input channel” if you do not need it, otherwise one recording channel is missing! In “Amplifier”, please choose FA64I/S and in “MEA” FlexMEA72. In Layout tab of the display, please click ”Default Map”.

The letter digit code below is the electrode identifier and refers to the position of the electrode in the grid.

Note: The MC_Rack channel map is constructed by looking on the back side of the electrodes!

Please make sure to connect the left hand side of the FlexMEA72 contact pads (electrode side on top) via ADPT-FM-72 adapter to the first MPA32I (channels 33 to 64), and the right hand side to the second MPA32I (channels 1 to 32). Read the SC2x32 data sheet when using a signal collector.

The electrodes are on the same side as the contact pads. The side with the writing “NMI” is the side with the contact pads and electrodes. It might be a bit confusing that the pads look “stronger” from the wrong side, but if you hold the FlexMEA72 into the light, you see that the contact pads have a three-dimensional appearance only from the correct side.

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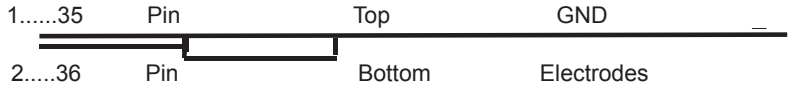
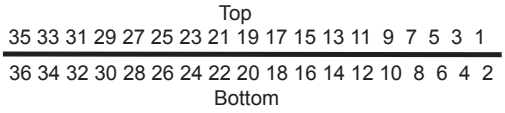
EcoFlexMEA24

Flexible Microelectrode Array with 24 electrodes for use with 32-Channel Miniature Preamplifer MPA32I for *in vivo* or *in vitro* applications.





Connect the EcoFlexMEA24 directly to a 32-Channel Miniature Preamplifier.
The electrode field is at the bottom of the EcoFlexMEA24.
Insert the EcoFlexMEA24 into the MPA32I with the electrode field up.

Technical Specifications EcoFlexMEA24

Temperature compatibility	10 - 125 °C
Dimension (W x D)	36 mm x 25 mm
Thickness (region of electrodes)	50 µm
Base material	Polyimide (Kapton)
Contact pads and leads	Gold
Electrode diameter	80 µm
Interelectrode distance (centre to centre)	300 µm
Electrode heights	Planar
Electrode type	Gold
Isolation type	Polyimide (Kapton)
Electrode impedance	Approximately 30 - 50 kΩ
Electrode layout grid	10 x 2 + 4
Number of recording electrodes	23
Number of reference electrodes	2 internal reference electrodes
Number of ground electrodes	2 ground electrodes

MC_Rack	Version 4.1.1 and higher
Data Source Setup	Source Layout: Configuration, Total Number of Channels: 64, Amplifier: FA32I/S or FA64I/S, MEA: EcoFlexMEA24.
Channel map	Display: Layout tab > Default Map (EcoFlexMEA24.cmp).
Cleaning	Rinse with distilled water. EcoFlexMEAs are heat stable and can be autoclaved.

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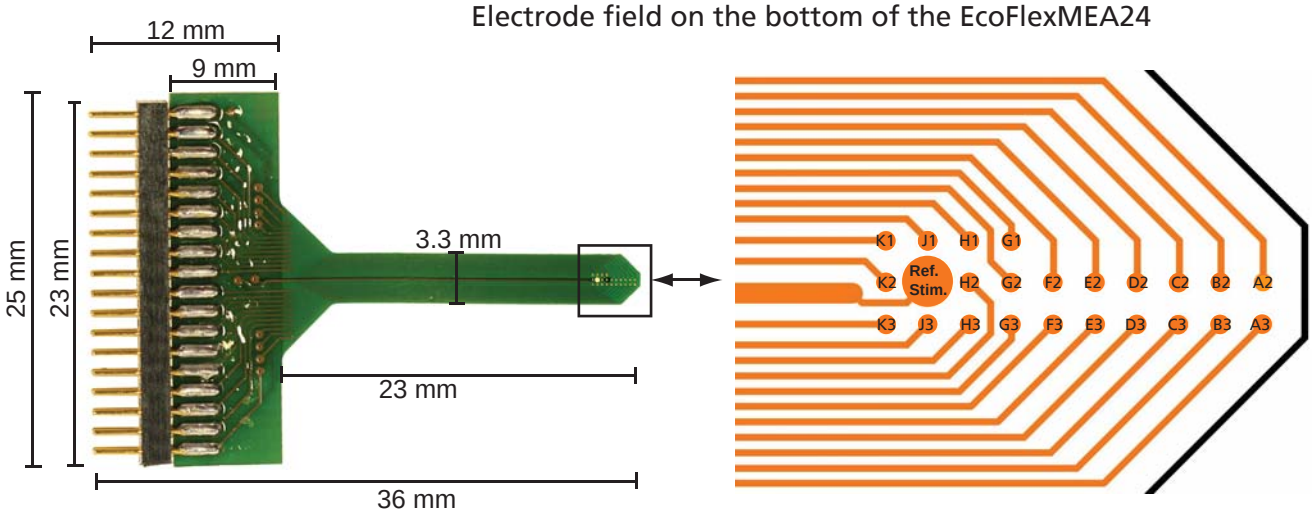
EcoFlexMEA24

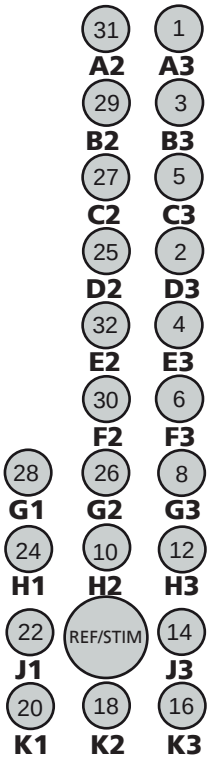
Electrode Layout


12 mm
9 mm
25 mm
23 mm
3.3 mm
23 mm
36 mm
Electrode field on the bottom of the EcoFlexMEA24
K1 J1 H1 G1
K2 Ref. Stim. H2 G2 F2 E2 D2 C2 B2 A2
K3 J3 H3 G3 F3 E3 D3 C3 B3 A3

EcoFlexMEA24 OUT / MPA32I IN

Pin		Electrode	MC_Rack Channel
Pin	1:	GND (Top)	
Pin	2:	Ref. / Stim.(Bottom)	
Pin	3:	A3	1
Pin	4:	D3	2
Pin	5:	B3	3
Pin	6:	E3	4
Pin	7:	C3	5
Pin	8:	F3	6
Pin	9:	not connected	7
Pin	10:	G3	8
Pin	11:	not connected	9
Pin	12:	H2	10
Pin	13:	not connected	11
Pin	14:	H3	12
Pin	15:	not connected	13
Pin	16:	J3	14
Pin	17:	not connected	15
Pin	18:	K3	16
Pin	19:	not connected	17
Pin	20:	K2	18
Pin	21:	not connected	19
Pin	22:	K1	20
Pin	23:	not connected	21
Pin	24:	J1	22
Pin	25:	not connected	23
Pin	26:	H1	24
Pin	27:	D2	25
Pin	28:	G2	26
Pin	29:	C2	27
Pin	30:	G1	28
Pin	31:	B2	29
Pin	32:	F2	30
Pin	33:	A2	31
Pin	34:	E2	32
Pin	35:	Ref. / Stim.(Bottom)	
Pin	36:	GND (Top)	

MC_Rack Channel Map



Warning: The device may only be used together with the MPA32I from Multi Channel Systems MCS GmbH, and only for the specified purpose. Damage of the device and even injuries can result from improper use.

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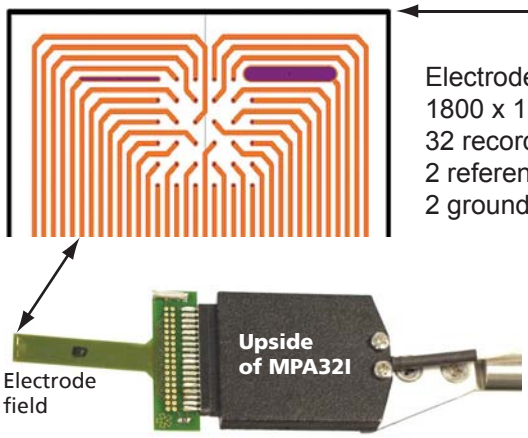
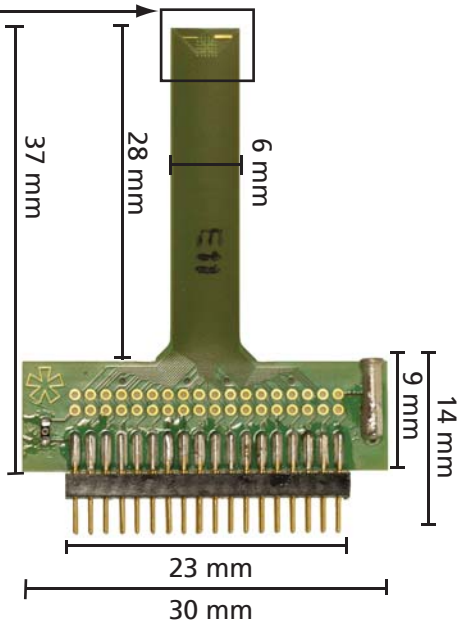
EcoFlexMEA36

Flexible Microelectrode Array with 36 electrodes for use with
32-Channel Miniature Preamplifier MPA32I for *in vivo* or *in vitro* applications.



Electrode field:
1800 x 1800 µm,
32 recording electrodes,
2 reference electrodes,
2 ground electrodes



Connect the EcoFlexMEA36 directly to a 32-Channel Miniature Preamplifier. Insert the EcoFlexMEA36 into the MPA32I with the electrode field up, when the backside of the MPA32I with the screws is upside down. The additional connector can be used for connecting a silver pellet or a silver wire for grounding the bath.

Technical Specifications EcoFlexMEA36

Temperature compatibility	10 - 125 °C
Dimension (W x D)	37 mm x 30 mm
Thickness of the electrode field	50 µm
Weight	< 10 g
Base material	Polyimide (Kapton)
Contact pads and track material	Gold
Electrode diameter	50 µm
Interelectrode distance (centre to centre)	300 µm
Electrode height	Planar
Electrode type	Gold electrodes
Isolation type	Polyimide (Kapton)
Electrode impedance	Approximately 50 kΩ
Electrode layout grid	6 x 6
Number of electrodes	36
Reference electrodes	2 internal reference electrodes
Ground electrodes	2 ground electrodes
MC_Rack	
Source layout in “Data Source Setup”	1 dimensional, 32 channels, **no** digital channel
Channel map	EcoFlexMEA36.cmp
Cleaning	Rinse with distilled water. EcoFlexMEAs made from Polyimide (Kapton) are heat stable and autoclavable.

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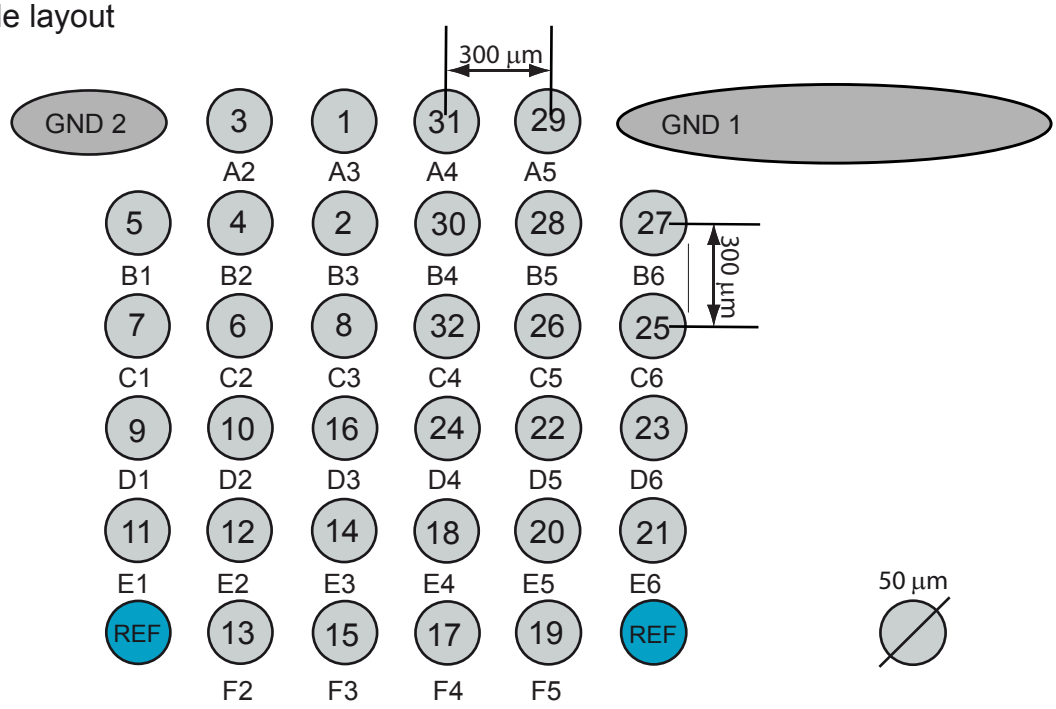
EcoFlexMEA36

Electrode layout



GND 1 is a large ground electrode connected to pin 1 of the MPA32I input connector. GND 2 is a second ground electrode connected to pin 36. The REF electrodes are reference electrodes connected to pin 2 and 35, respectively. Both ground inputs and both reference electrode inputs are equal, that is, they are connected to each other inside the standard MPA32I. Please see the MPA32I manual for details.

The numbers in the electrodes are the recording channel numbers that refer to the channel numbers in the MC_Rack program. Please make sure that you have selected “Configuration” in the “Channel Layout” under “Data Source Setup” with a total number of 64 channels. Deselect the check box “Digital input channel” if you do not need it, otherwise it could be that one recording channel is missing! In “Amplifier”, please choose FA32I/S or FA64I/S and in “MEA” EcoFlexMEA36. In Layout tab of the display, please click ”Default Map”.

The letter digit code below is the electrode identifier and refers to the position of the electrode in the grid.

Important: The MC_Rack channel map is constructed by looking on the back side of the electrodes, because the FlexMEA electrodes are placed on the preparation upside down!

If you use a MEA64-System with more than one MPA32I, the signal collector SC2x32 leads the output channels of the second amplifier to channel numbers 33 to 64. Please read the SC2x32 data sheet.

Warning: The device may only be used together with the MPA32I from Multi Channel Systems MCS GmbH, and only for the specified purpose. Damage of the device and even injuries can result from improper use.

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